PRACTICAL AGRICULTURE

COMPREHENDING

THE CULTIVATION OF PLANTS,
THE HUSBANDRY OF THE DOMESTIC ANIMALS,
AND THE ECONOMY OF THE FARM.

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PREFACE.

The Agriculture of a country is affected, in its general character and details of practice, by climate, the fertility of the soil, and the food and habits of the people. Climate chiefly determines the plants to be cultivated and the order of the labours of the season, and modifies all the practices of the husbandman. Even within no great extremes of temperature, the practice of the farmer must be varied to suit the differences of climate. Thus, the agriculture of the south of France is not the same as that which is established in Normandy and other departments of the North; and in Italy, where, along with the productions of northern climates, are cultivated the rice, the maize, the Indian millet, and other plants of warmer regions, the agriculture differs in many parts of practice from that of the corn-exporting countries of the north of Europe.

To treat of agriculture, therefore, as a practical art, without reference to some given conditions of climate and country, would embrace a wide range of observations, and the consideration of a great mass of details. It would involve the examination of many opposite practices, in themselves perhaps good and adapted to the circumstances which gave rise to them, but, as a whole, unsuited to any one condition in which the farmer could be placed, and thence incapable of being reduced to practice. That instructions in agriculture therefore, may avail for useful purposes, they must have reference to a system applicable to some given condition of climate and country. In this way the study will be rendered more easy to those who enter upon it for the first time: and not only will the student make the most ready progress, but he will acquire the most useful species of knowledge. For, however different be the natural productions of countries, and however necessary it be that the farmer adapt his operations to these differences, yet there are rules and maxims in the art common to the husbandry of all countries; and he who is thoroughly acquainted with one good system of practice applicable to any one situation of the farmer, has the means, by an easy analogy, of applying his knowledge to other and dissimilar cases. A person thoroughly trained to practice on the banks of the Tweed, would make a good farmer on the banks of the Po or the Ohio. He has received the kind of instruction which is useful under all circumstances, and quickly learns to adapt his details of practice to the new circumstances under which they are to be applied.

In describing a system of agriculture, too, it is important that, while it is one which admits of being carried into easy effect, it shall be as perfect as, under this necessary condition, it can be rendered. A rude system of practice will not serve the purpose of useful example. Although the agriculturist may not be able to reach in all things the model proposed to him, it is yet important that this model be good in itself, so that his own practice may become as perfect as the circumstances in which he is placed will allow.

Agriculture, like every art, is founded upon principles, and a natural method of studying it would seem to be, to begin with principles, and from these to deduce the rules of practice. The nature of the subject, however, or rather the state of our knowledge, admits of this course being followed only to a limited extent: for the art founded on experience is often better understood than the principles; and while the science is in some degree incomplete, the art has in many things been rendered very perfect by experience alone. Hence it is well to lay the foundation of the study of agriculture on a knowledge of practice. In this case the agriculturist, should he desire to extend the range of his observations to the relations of the sciences with the practical art, will do so with a more useful result, and less hazard of error.

In the following work, which is designed in an especial manner for those who are to engage in the study of agriculture for the first time, I propose to observe the plan of instruction to which I have referred. One condition of climate and country is assumed, and there is explained, in so far as the limits of an elementary work will allow, a system of agriculture, which is conceived to be good, which is founded on experience, and which is capable of being reduced to practice. It does not therefore consist with the design of this work, to detail a number of practices or examine a number of opinions; many of which may be good, and yet not in accordance with the system to be explained. Further, the attention of the reader is mainly directed to the essential parts of practice; and while the connexion of agriculture with other branches of knowledge is carefully pointed out, this is in most cases done rather to show the relation between them than to pursue the subject in detail.

The application of Science to Agriculture affords the materials of interesting and useful study. Chemistry ascertains the nature and constitution of soils, the mode of action of manures, and the substances fitted for the nutrition of plants; Botany and Vegetable Physiology treat of the structure, the properties, and the uses of plants; Animal Physiology and Medical Science relate to the form of animals, their properties and diseases; and Mechanics are applied to the construction of machines and rural works. But these are branches of agriculture which may be separately studied. They are not essential, as experience shows, to the knowledge of agriculture as an economical art, and need be but partially treated of in an elementary work. Notwithstanding, how-even of this limitation in the design of the present treatise, it will appear that it is sufficiently extended for those who enter for the first time on the study of Agriculture; and that even a rudimental knowledge of so many subjects as it embraces cannot be acquired without the labour of patient study.

The favour with which the former Editions of this Work have been received in this and other Countries, encourages me to adhere strictly to the plan before adopted. But I embrace the opportunity afforded by another Edition, to make some amendments in minor points, several additions to the list of Farm Implements and Machines, and certain corrections in the accounts given of the breeds or varieties of the Domestic Animals. A more extended investigation of the effects of climate, food, and culture, in modifying the form and character of these animals, has qualified me to give greater correctness to the descriptions of our breeds; and I trust, in another Work to be devoted to the Economy of the Domestic Animals, to be enabled to treat of the entire subject in further detail than consists with the design of the present treatise.

It has been objected to some of the calculations contained in this Work, that the rate of labour assumed will not apply to a great part of England. This objection is good in the case of various districts of very stiff aluminous or alumino-calcareous soils in the south-eastern counties of England, where more than the labour of two horses may be required for ordinary tillage; but it certainly does not apply to the greater part of the land of this country. The System of Agriculture here explained, in so far as it regards the methods of farm labour, has been long established in the north of England, and over all the better districts of Scotland. In the County of Northumberland, where a system of cultivation is pursued which may serve as a model to every part of this kingdom, the stiffest soils are managed by two-horse teams. While I must admit, then, the exceptions which exist in the case of certain tracts of country, as the London clay, the weald clay, and other very tenacious soils, I maintain that the system of farm-labour here described, is capable of being reduced to practice over nearly nine-tenths of England: and to the whole of Ireland it is applicable in its minutest details. The greatest obstacle to the progress of agricultural improvement, is the prejudice of habit. Throughout all England there is a multitude of agriculturists surpassed by none in the world for intelligence and spirit, and many things in the agriculture of the country are deserving of the highest praise; but it cannot be concealed, that, in the simplifying and economising of labour, there is much to be learned and effected. It is in this respect, that the methods of English tillage, and especially in the southern counties, admit of the greatest improvement. By a more efficient application of the means of labour, a wide field of beneficial improvement is open over a great part of this rich and beautiful country; and one of the most useful services that can be rendered to the farmers of many of the finest districts of England, is to show them how the operations of the field can be more cheaply performed. It is undeniable, that, in the parts of this kingdom which are the least favoured by nature, the art of tillage has become more perfect by being rendered more simple ; and the result is shown in the greater revenue derived from land under all the disadvantages of a colder, moister, and more changeable climate. The agriculturists in the south of England are surprised at the high rents paid from the poorer soils in the northern parts of the kingdom. This doubtless arises from a combination of causes ; but not the least important of these is a simpler and cheaper system of farm labour.

I have only further to observe, with respect to the present as to the former Editions, that I have made use of portions of a few essays written by me in the Quarterly Journal of Agriculture. The principal of these are, descriptions of soils, of the plough, of the harrow, and other implements of the farm ; accounts of the turnip culture, and of irrigation ; the subject of the lease, and a few of lesser interest.

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The Weights and Measures referred to are the standard English acre, containing 4840 square yards; the gallon, consisting of 277.274 cubic inches; the pound avoirdupois; and the stone of 14 lb.

ELEMENTS

OF

PRACTICAL AGRICULTURE:

I. SOILS.

1. THE CLASSES OF SOILS, AND THEIR PROPERTIES, AS DETERMINED BY EXTERNAL CHARACTERS.

The Soil is the upper portion of the ground in which plants are produced. It forms a stratum of from a few inches to a foot or more in depth. It is usually somewhat dark in colour, arising from the mixing with it of the decomposed stems, leaves, and other parts of plants which had grown upon it, and in part often from the presence of animal substances. It is this mixture of the substance of organic bodies, with the mineral matter of the upper stratum, which distinguishes this stratum from the subjacent mass of earth or rock, to which the term Subsoil is applied. The decomposed organic portion of the soil may be termed *mould;* and it is the presence of mould, accordingly, which distinguishes the soil from the subsoil.

Soils are very various in their fertility and texture. With relation to their powers of producing useful plants, they may be termed rich or poor; with relation to their texture, they may be termed stiff,—and free or light. The stiff soils are those which are tenacious and cohesive in their parts; the light or free soils are those which are of a looser texture, and whose parts are easily separated. But the cohesive soils pass into the loose by imperceptible gradations, and hence though all soils may be termed rich or poor, stiff or light, they are so in every degree of fertility and texture.

All soils which possess this tenacious or cohesive property in a considerable degree, are termed *clays* or clayey soils; while all the looser soils are termed *light* or *free*. And all soils are more or less clayey, or more or less light, as they possess more or less of this tenacious and cohesive property, or of this looser texture.

The fertility of soils is, *cæteris paribus*, indicated by the greater or smaller proportion of mould which enters into their composition. When soils are thus naturally fertile, or are rendered permanently so by art, they are frequently termed *loams*: Thus, there are clayey loams and sandy loams; and peat itself may, by the application of labour and art, be converted into loam.

The parts of plants which grow upon the surface, and are mixed with the mineral matter of the soil, may decompose and become mould. Under certain circumstances, however, the plants which have grown upon the surface do not decompose, but undergo a peculiar change, which fits them to resist decomposition. They are converted into peat, and the soils formed of this substance, are termed *peaty*. The peaty soils are of the lighter class, and are distinguished from all others by peculiar characters.

Soils, then, may be distinguished from one another:—

1st, By their texture, in which case they may be divided into two classes,—1st, the stiff, denominated clays; 2d, the light or free, comprehending the peaty.

2d, By their fertility or powers of producing useful plants, in which case they are termed rich or poor.

Soils, too, from particular causes, may be habitually wet or habitually dry. Soils, therefore, may be further distinguished by their general relation to moisture. When water, from any cause, is generally abundant, the soils may be termed wet; when there is habitual deficiency of water, they may be termed dry.

Subsoils, it has been said, are distinguished from soils properly so termed, by the absence of mould. Plants, in growing, may extend their roots into the subsoil, and; decomposing there, be mixed with it. But this is in small quantity, and, for the most part, the subsoil is readily distinguishable by the eye, from the upper stratum or soil, by the absence of organic matter in a decomposed or decomposing state.

Subsoils may either consist of loose earthy matter like the soil, or they may consist of rock. Subsoils, therefore, may be divided into two classes, the rocky and the earthy.

When the soil rests directly upon and extends to the rock, without any intervening bed of looser earthy matter, the soil will frequently be found to be similar in the composition of its mineral parts to the rock upon which it rests, from having been formed by the gradual disintegration of that rock. This is chiefly found to be the case with the soils of mountains; for, in plains, the soil is generally formed, not by the disintegration and decomposition of the rock upon which it rests, but by the intermixing together of the disintegrated parts of different rocks and mineral strata.

The rocky subsoils consist of granite, sandstone, limestone, chalk, and the other mountain-rocks of a country. They are sometimes easily penetrated by the water that falls upon the soil, and are then termed free or porous; and sometimes they resist the percolation of water, when they are termed close or retentive.

The earthy subsoils may, in like manner, be divided into the close or retentive, and the free or porous. The retentive are those which, from containing much clay, are tenacious and cohesive in their parts, and little pervious to fluids: the porous are those which, having less of clay in their composition, are more readily permeable.

Whether the subsoil be retentive or porous, the soil which rests upon it should be of good depth. If the soil be shallow on a retentive subsoil, it is affected too greatly by the alternations of dryness and moisture. And if, again, a shallow soil rests on a porous subsoil, the moisture of the soil is too easily acted upon and exhausted by heat.

A subsoil, in so far as mere texture is concerned, should be neither too retentive nor too porous. But although this intermediate condition is in most cases the best, yet in a very cold and moist country, a free or porous subsoil is for the most part to be preferred to one which is close and retentive. The soil, besides being affected by the texture of the subsoil, is sometimes also affected by the nature of the mineral substances of which the subsoil is formed.

If the subsoil be rocky, it is desirable that it be calcareous rather than siliceous,—chalk or limestone, for example, rather than quartz. Sometimes the subsoil contains matter which is directly injurious to the growth of plants. This matter is generally found to be the oxides of metals in combination with acids. Subsoils of this kind are usually distinguished by deepness of colour.

Soils, then, it is seen, are affected in their properties not only by their own texture and composition, but by the texture and composition of the subsoil; and they are divided into the Stiff or Clayey, and the Light or Free.

The Clayey Soils have, as their distinguishing character, the adhesiveness of their parts; and this property alone will enable even the inexperienced to discriminate them. A stiff clay, when dried either by natural or artificial heat, becomes so hard as to resist a considerable mechanical pressure. On account of the tenacity of such soils, they are tilled with more difficulty than the freer soils. They require, to fertilize them, a larger proportion of manures; but they retain the effects of these manures for a longer time. They are better suited to the cultivation of plants with fibrous than with fleshy roots or tubers.

Soils of this class, as of every other, possess many degrees of natural fertility. The poor clays form, for the most part, an unprofitable soil, because, while their powers of production are inconsiderable, the expenses of tilling them are large. The clayey soils of this character are generally of little depth, and rest upon a retentive subsoil. The natural herbage they produce is coarse and little nutritious, and they are not well suited to the production of the cultivated grasses and other herbage plants. They are little fitted for the growth of turnips, or other plants with fleshy roots or tubers. Such soils have everywhere local names which sufficiently denote their qualities. They are termed, by not an improper figure, *cold* soils; and sometimes they are classed under the general name *moor*, which term is often used to denote soils, whatever be their nature, of a low degree of fertility.

Very different in their value and nature are the richer clays. These bear weighty crops of all the cultivated kinds of corn; they do not excel the better soils of other classes so greatly in the production of oats, and still less in that of barley, in which the lighter loams may surpass them; but they are unequalled for the production of wheat, and in many places, derive their descriptive appellation from that circumstance, being termed *wheat* soils. They are well suited for the growth of the bean, a plant with a weighty stem, and requiring a stiff soil to support it. They will yield large returns of the cultivated grasses and leguminous herbage plants, though they are not so quickly covered with the natural herbage plants of the soil, when laid down to perennial pasturage, as the lighter soils.

Clays, like the other soils, approach to their most perfect condition, as they advance to that state which has been termed loam. The effect of judicious tillage, and of the application of manures, is to improve the texture of such soils as well as to enrich them. Thus, clays in the neighbourhood of cities become dark in their colour and less cohesive in their texture, from the mixture of animal and vegetable matter, and thence acquire the properties of the most valued soils of their class.

Natural changes, however, yet more than art, have furnished the rich soils of clay. The best, for the most part, of the soils of clay, are those which are formed from the alluvial depositions of rivers or the sea. The finest natural soils of this and other countries are those which are thus formed. The depositions of rivers, indeed, are not always of a clayey nature. In mountainous districts they generally form soils of the lighter kinds. Where the sea, however, is the agent, or where both the rivers and the tides combine their action, the depositions generally partake of the nature of clay. Such alluvial soils have every-where local terms to mark their character and fertility. On the great rivers and estuaries in England, and in what are termed *carses* in Scotland, fine and extensive districts of this kind exist.

The next class of soils is the Light or Free. These are readily distinguished from the last by their smaller degree of tenacity. They are less suited for the production of wheat and beans than the clays, but they are better suited for the production of plants cultivated for their roots and tubers, as the turnip and the potato.

This class of soils may be divided into two kinds, or sub-classes, differing from each other in certain characters, but agreeing in the common property of being less tenacious in their parts than the clays.

The first of these sub-classes of the lighter soils has been termed the Sandy.

The sandy soils are of all the degrees from barrenness to fertility. When wholly without cohesion in their parts, they are altogether barren, and are only rendered productive by the admixture of other substances. The cultivated sands part readily with their moisture on the application of heat. They do not become hard like the clays, and, making no considerable resistance to external pressure, they are tilled with little labour.

The poorer sands are almost always marked by the scantiness of their natural herbage. This character they possess in common with the poorer gravels. Other soils, even the poorest, may be thickly covered with the plants peculiar to them; but the poorer sands and gravels usually put forth their natural herbs with a sparingness which denotes the absence of vegetable nourishment.

But sand, without losing its distinctive character as a soil, may possess a greater cohesiveness in its particles, and be fertile by nature or rendered so by art; and then the soils denominated sandy become of deserved estimation. Rich sands are early in maturing the cultivated plants, and thence they are familiarly termed kindly soils. They are fit for the production of every kind of herbage and grain. They yield to the richer clays in the power of producing wheat, but they surpass them in the production of rye and barley. They are well suited to the growth of the cultivated grasses; and, when left in perennial pasture, they are quickly covered with the natural plants of the soil. But their distinguishing character is their peculiar adaptation to the raising of the plants cultivated for their roots and tubers.

The next division of the lighter soils, and allied in characters to the sandy, is the Gravelly.

Sands will frequently be found to be the production of flat countries, gravels of the mountainous and rocky. The characteristic of the gravelly soils is the quantity of loose stones which they contain. These stones will be found to consist of those varieties of rock which the mountains of the country afford; and the nature of these rocks will frequently indicate the characters of the soil; thus soils, of which the stony matter is very siliceous, are generally found to be barren, while those of which it is calcareous are found to be fertile.

Sands, upon examination, will be found to consist of small particles of stony matter, and thus sands may be said to differ from gravels only in the more minute division of their parts. Yet, in this minuteness of division, there is generally sufficient to distinguish the two kinds of soils. The stony matter of the sand forms its principal component part, while the larger stones in the gravel, which give to it its name and character, seem only to be mixed with the other necessary parts of the soil. The stone of the one has undergone a considerable mechanical division, while much of that of the other has only been loosened, in sensible masses, from its native bed. Any light soil, mixed with a sufficient portion of stones, is gravel; and gravel, therefore, is nothing else than the different kinds of light soils, mixed with a greater or less proportion of stones.

Gravels, like sands, have all the gradations of quality, from fertility to barrenness. The loose soils of this nature, in which the undecomposed material is great, and the intervening soil siliceous, are held to be the worst of their kind. These are, in some places, termed *hungry* gravels, not only to denote their poverty, but their tendency to devour, as it were, manure, without any corresponding nourishment to themselves. As the texture and quality of the intervening earth improve, so does the quality of the entire soil; and gravels, like sands and clays, advancing through all the intermediate degrees, may become at last of great fertility.

The rich gravels will produce all the cultivated kinds of grain. Their looser texture renders them less suited than the clays to the growth of wheat and beans, but they are admirably adapted to the growth of barley and oats. They are quick in their powers of producing vegetation; and, from this quality, they are, in some places, termed *sharp* or quick soils. They readily admit of alternations of herbage and tillage, and improve in a state of perennial pasturage. They are generally trusty soils with regard to the quality of the grain which they yield; and, in this respect, they differ from many of the sands, in which the quality of the grain produced does not always accord with its early promise. It is well, then, even in the best sands, to see a tendency to gravel, which denotes a sharpness, as it is termed, in the soil. Gravels, like sands, are suited to the culture of the different kinds of plants raised for their roots and tubers; and they are in so peculiar a degree suited to the growth of turnips, that, in some parts, they receive the distinguishing appellation of *turnip* soils.

The last division of the lighter soils consists of those which are termed Peaty.

The matter of the soils of this class is dark in its colour, spongy in its texture, and full of the stems and other parts of plants, either entire or in a state of partial decay. It is generally tough and elastic; and, when dried, loses greatly of its weight, and becomes inflammable. These, the most observable characteristics of the soils termed peaty, will distinguish them, in their natural state, from every other; and, even when they shall have been greatly improved by culture, enough of their original characters will remain to make them known.

Peat, it has been said, consists of vegetable matter which has undergone a peculiar change. Under a degree of temperature not sufficiently great to decompose the plants that have sprung up upon the surface, these plants accumulate; and, aided by a certain degree of humidity, are converted into peat, which is either found in strata upon the surface of plains, or accumulated in great beds on the tops and acclivities of mountains, or in valleys, hollows, and ravines. Successive layers of plants being added to the mass, it continues to increase, under circumstances favourable to its production. Water is a necessary agent in its formation, and we may believe, too, a peculiar temperature, since it is only in the cold and temperate, and not in the warmer regions of the earth, that it is found to be produced. The plants which form it have not entirely decayed, but still retain their fibrous texture; and, from the action of certain natural agents, have acquired properties altogether distinct from those which, in their former condition, they were possessed of. They have now formed a spongy elastic inflammable body, and so different from the common matter of vegetables, as to be highly antiseptic.

The plants whose progress towards decomposition has been thus arrested, are very various. Over the greater part of the surface of the primary and transition districts of colder countries, the peat is chiefly formed of mosses, and other cryptogamic plants, mixed with the heaths and other plants which had grown along with it. Sometimes the peat has been formed in swamps and lakes, and at other times the humidity of the climate has been sufficient to form it in one continued bed, covering the whole surface of the country.

Of the heaths which enter into the composition of peat, that hardy species the common ling, *Calluna vulgaris*, is the native inhabitant of the alpine countries of northern Europe, and grows in vigour, and overspreads the surface, where hardly any of the other larger plants would live. But although this and other species of heath are very generally converted into peat, this is not necessarily or universally so. By the growth and decay of the roots and stems, a soil is indeed formed; but then this may take place in the same manner as in other soils, and without the actual conversion of the upper stratum into peat. This, however, in the case of the cold and moist countries of the north of Europe, is comparatively rare, for generally the heaths, from the slowness of decomposition of their ligneous roots and stems, are wholly or partially converted into peat. In the cases in which these plants are not converted into peat, a dry and turfy soil is formed, different in aspect from that formed by the gramineous and other easily decomposed plants, but still produced in the same manner, though, like the peaty soils, elastic and inflammable, on account of the great quantity of ligneous matter in its composition. The soil itself is generally thin and little favourable to vegetation. It usually rests upon a subsoil of siliceous sand, and sometimes of chalk, and then it is comprehended under the class of soils termed light.

The soil formed of peat would, from its vegetable composition, seem to contain within it the necessary elements of fertility, and yet this is not found to be so. The excess of vegetable matter which it contains is injurious rather than useful. In the state of nature it is often found to be as barren as the sand of the desert, and scarcely to deserve the name of soil, until the labour of art has been extended to its improvement, and even then it is not entirely divested of its original characters.

The effect of a thorough draining off of the water of peat, continued for a long time, is to carry away the antiseptic matter which it contains. When the water of peat has ceased to be turbid, and comes off clear, then we have the assurance that the peat is freed of the principles injurious to vegetation. This is the greatest improvement of which peat is susceptible, and when we have brought it to this condition, the main difficulty of improving it has ceased.

Peat may then be brought to the state of what has been termed loam. In this ameliorated condition it becomes a soil of the lighter kind, well suited to the culture of the larger-rooted plants. It is dark in its colour like the richest vegetable loam, and to the inexperienced eye may pass as such. But still, unless greatly corrected in its texture by the application of the earths, it is found to be porous and loose, too quickly saturated with moisture, and too easily freed from it. In this improved condition it will yield bulky crops of oats and barley, although the quantity of the grain will not always correspond with the weight of the stem, nor the quality of the grain with its quantity.

Soils, then, we have seen, may be distinguished according to their texture and constitution, when they may be divided into two classes,—the stiff or strong, denominated Clays,—the light or free, subdivided into the Sandy, Gravelly, and Peaty; and all these, again, may be distinguished,

1*st*, According to their powers of production, when they are termed Rich or Poor; and

2*d*, According to their habitual relation with respect to moisture, when they are termed Wet or Dry.

This simple nomenclature of soils is sufficiently intelligible to the practical farmer. The farmer regards soils chiefly with relation to their fertility, and the means of cultivating them, and he naturally classifies them according to these views. A main distinction between soils, in practice, is founded upon their comparative productiveness, and this is the distinction which is most important with regard to mere value. We constantly refer to soils with reference to their good or bad qualities, without adverting to the particular circumstances which render them of good or bad quality. We speak familiarly, for example, of land worth 30s. 40s. and 50s. the acre of yearly rent, without considering whether it be a fertile clay, a fertile sand, or a highly improved peat. We speak of it with reference to its fertility and value alone. But those other distinctions, which are derived from its constitution and texture, are essential when we regard the manner of cultivating such a soil; for the same method of tillage, and the same succession of crops, as will be afterwards seen, do not apply to all rich or to all poor soils, but are determined by the character of the soil, as derived from its other properties.

Though soils are thus distinguished by external characters, they pass into one another by such gradations, that it is often difficult to say to what class they belong. These intermediate soils, too, are the most numerous class in all countries. The soils termed peaty, indeed, form a peculiar class, always marked by distinctive characters; but even these, when mixed with other substances, pass into the earthy soils, by imperceptible gradations. We may say, therefore, that the greater part of soils consists of an intermediate class, and that it is often difficult to bring them under any division, derived from their texture alone. Such soils, however, can always be distinguished by their powers of production. They are good, bad, or intermediate between good and bad; and their relative value is determined by the produce which, under similar circumstances, they will yield.

II. THE PROPERTIES OF SOILS AS DETERMINED BY CHEMICAL ANALYSIS.

Having examined the external characters of soils, we might inquire into their properties, as determined by chemical analysis. This, however, is a branch of the extensive subject of agricultural chemistry, into which it would not be consistent with the practical and elementary nature of this work to enter at length. It is merely proposed, therefore, to direct the attention of the reader to this part of the science of agriculture, and to make known to him a few results which have been arrived at.

The soil has been said to be a compound of mineral substances, mixed with a portion of vegetable and animal matter.

The vegetable and animal matter of the soil exists either in a state of mixture, or of chemical union with the minerals of the soil.

The mineral matter of the soil forms greatly the larger part of it, and necessarily consists of the same substances which constitute the mountain-rocks and mineral masses which are found on the earth, and which form its crust or covering. The hardest rocks break down by degrees, and are decomposed by the influence of air and moisture. Sometimes the decomposed matter remains upon the rocky basis from which it had been derived, and there forms a soil; but more frequently the action of water has mingled together the different mineral masses and strata which are found on the earth.

The great body of the soil, then, is a mixture of the various mineral substances which are upon the earth, and is resolvable into the same constituent parts. Now, all the rocks and other mineral masses which exist on the surface of the earth, are found to consist of a few bodies, the principal of which are four earths,—silica, alumina, lime, and magnesia,—oxide of iron, soda, and potassa. In like manner, the great mass of the mineral part of the soil is resolvable into silica, alumina, lime, magnesia, oxide of iron, soda, and potassa.

The manner in which this compound body may be conceived to exist is the following: Let it be supposed that the different minerals on the surface of the earth are more or less decomposed, broken, ground down, as it were, and mingled together.

Some are in the form of stones, and are therefore merely varieties of the different rocks of a country. These form loose stones and gravel, which we see accordingly to be everywhere mingled with the soil, and to form often a great proportion of it.

A more minute comminution reduces these mineral substances to sand. This is the form in which the largest part of all soils exists, and when it is in a very considerable proportion to the whole, the soil is termed Sandy.

When the parts are more comminuted still, and reduced by chemical or mechanical means to powder, the soil appears to be in the state favourable to vegetation. All our finest soils contain a large comparative proportion of their parts reduced to this state of division; and where none of this finely divided substance, or a small quantity of it only, exists, the soil is barren.

Of the substances which form the constituent parts of minerals, the most widely diffused is silica. Stones in which it exists in large quantity are usually very hard. The sand of the sea-shore is mostly siliceous, and siliceous sand forms vast deserts in every part of the world.

In quartz, and in felspar, silica exists nearly pure, and it forms 98 parts in 100 of common flint. It is from its abundance in quartz, a mountain-rock of universal diffusion, and in felspar, which is likewise one of the most abundant minerals in nature, that silica is important as forming a principal constituent part of all the loose mineral matter of the surface of the earth, and consequently of all soils. Quartz is a rock of constant occurrence, and its disintegrated parts have been everywhere washed into the plains to form an element of the soil. Quartz has been found to consist of silica, alumina, and a small quantity of oxide of iron. Quartz is also an integrant part of sandstone, and other rocks of general diffusion. It enters largely into the composition of granite and other primary rocks. It forms, in short, a part of the rocks in all the series of formations which geologists enumerate; and thus silica is the most universally diffused mineral substance on the surface of the earth, and forms a part, accordingly, of every soil that is known to us.

Alumina, next to silica, is the most generally diffused of the earths. United with silica, it forms a great proportion of all the rocks and mineral masses on the earth. It is accordingly everywhere found; and forms a part of every soil not wholly barren. Kneaded with water it becomes a ductile paste, and is the substance which chiefly gives their plastic and ductile characters to the soils termed clays. It retains water more strongly than any of the other earths.

Silica and alumina, then, forming the largest part of the rocks and minerals which exist upon the surface of the earth, enter the most largely into the composition of soils; and in these they are found to exist, either as grains of sand, or as gravel, or in the form of a fine powder.

Lime, the next of the earths, is one which is of wide extension, and performs an important function in the vegetable economy. In nature this mineral is usually found in combination with acids. Combined with carbonic acid, it constitutes the numerous varieties of marble, limestone, and chalk. In this and other combinations, it exists in rocks, in soils, in the waters of the ocean, in plants, and in animals. It forms great beds, and numerous minerals in combination with silica and alumina.

It is chiefly from the carbonate that the lime used in agriculture is derived. By exposing the carbonate to a strong heat, the carbonic acid is driven off, and that which remains is the caustic earth, to which we give the name of quicklime. This substance has a strong affinity for water, which it will absorb from the atmosphere. When the water is applied in quantity, it is absorbed by the lime, with a great evolution of heat; and this is the process of slacking so well known. The lime thus combined with water attracts carbonic acid, and again becomes carbonate of lime; although, in this state of carbonate, it presents external characters entirely different from those which it possessed in its original state of marble, limestone, and chalk. But it is in external characters only, and in the lesser degree of cohesion of its parts, that it differs, for otherwise the substances are the same.

By the minute division of its parts by heat, we are enabled to apply lime to the soil in the state of a finely divided powder, and thus in the best form for improving the texture of the soil. It is from this cause doubtless, as well as those important purposes which it serves as a manure, that this earth is of such importance to the husbandman. Could we apply the earths silica and alumina to the soil in their pure state, or could we reduce them by mechanical or chemical means to powder, we should be able to apply them in a form calculated to improve the texture of the soil.

Lime exists in all soils formed by the decomposition of rocks;

but in soils formed wholly by the aggregation of vegetables, *as peat, it does not necessarily exist.* It improves the quality of all soils, whether they are formed of silica, alumina, or vegetable matter.

Silica, alumina, and lime, forming the principal part of soils, and, where any one of them prevails, giving its character to the soil, it is frequently convenient to distinguish soils, as being Siliceous, Aluminous, or Calcareous. Where silica prevails, as in the case of many sands, we may call the soil siliceous; where clay prevails we may call the soil aluminous; and where lime exists in quantity, as in the case of chalk, we may call the soil calcareous. Thus, in addition to the less artificial division of the farmer, derived from the texture and external characters of the soil, we may use those derived from its composition.

Magnesia, in various states of combination, exists in nature in considerable quantity. It is generally found in combination with acids, as the carbonic. It exists along with silica, alumina, lime, iron, and other substances. The minerals of which it forms a part, generally feel soft and unctuous. It is the principal constituent of various mountain-rocks, as serpentine and chlorite-slate; and thus being an element in many rocks and minerals, it must form a considerable part of soils. Magnesia, however, is less generally diffused than lime, and may perhaps perform a less important function in the economy of vegetation. When it exists in such quantity as to give a character to the soil, we may term the soil Magnesian.

The next substance that exists largely diffused in the mineral kingdom, is oxide, or rather peroxide, of iron.

Iron, as it is the most useful of the metals, so it is generally diffused on the earth. It is derived, for the purposes of the arts, from a series of minerals, termed ores of iron. It is found extensively in mountain-rocks; and it exists accordingly, in more or less quantity, in almost every soil. Its precise effects, however, on the productive powers of soils, have not been well determined; some soils, where it exists, being extremely barren, while in some very fertile soils, it exists in large quantity. Soils which contain much of iron may be termed Ferruginous.

The alkalies, soda and potassa, are also found in soils, being extensive products of the mineral kingdom. They are found in nature combined with various acids.

Soils, then, consist chiefly of silica, alumina, lime, magnesia, oxide of iron, potassa, and soda, together with a portion of matter derived from organic substances.

From various experiments, it is known, that plants consume in growing the decomposed animal and vegetable matter which the soil contains. It is rendered probable also by experiments, that a portion of the earthy matter of the soil,—the silica, the alumina, the lime, as well as various saline substances contained in it,—is absorbed by the plant, though in minute quantity, as compared to the animal and vegetable matter absorbed.

Further, the medium of supply of the matter of nutrition contained in the soil, may be regarded as water holding in solution the vegetable, animal, and other matters which pass into the roots of plants. The soil, then, may be chiefly regarded,

1st, As the instrument for fixing the roots of plants in the ground; and,

2d, As a medium for conveying to them the water holding dissolved the different substances which pass into the plant.

The air may be considered as a vehicle for conveying water to the soil. It is continually charged with aqueous vapour, which partly descends to the earth in rains, and is partly deposited in dews, in the cool of the night. In many countries it never rains at certain seasons, and the whole moisture is supplied by the dew. In this case in an especial degree, and in all cases in a certain degree, the power of the earth to absorb moisture from the air, may be regarded as connected with the means of the soil to nourish plants.

All our fertile soils, accordingly, have a power of thus supplying themselves with moisture, and of retaining it for the proper *time*; *while infertile soils* either have less of this absorbent power, or retain the fluid absorbed for a shorter time. This was known to the ancients, one of the marks which they gave of a fertile soil being, that it freely imbibed water.

Of the different matters which enter into the composition of soils, animal and vegetable substances possess the greatest power of absorbing moisture; and the addition of animal and vegetable substances always increases the fertility of soils.

Of the pure earths, the least absorbent is silica, and it is that also which parts the most readily with its moisture. A soil consisting of too great a proportion of siliceous sand is always infertile. It imbibes the aqueous vapour of the atmosphere with slowness, and parts with it quickly. A soil of siliceous sand will scarcely be penetrated by the dew of night, and will part with it on the first action of the morning rays of the sun.

While pure silica will imbibe scarce a fourth part of its weight of water, lime will absorb nearly its own weight, and alumina two and a half times its weight. But while the silica will absorb a smaller quantity than alumina or carbonate of lime, it will allow it to evaporate two times more quickly than carbonate of lime equally divided, and five times more quickly than alumina in the same state.* The addition of carbonate of lime or alumina to a soil containing too much silica, never fails to increase its powers of absorption and its fertility.

The order in which the principal substances that enter into the composition of soils possess an absorbent power, is the following:

1. Animal and vegetable substances.
2. Alumina.
3. Carbonate of Lime.
4. Silica.

It appears, too, that the more perfectly a portion of the soil is comminuted, decomposed, and reduced, the greater is the power of absorption which it possesses.

* Chimie appliquée à l'Agriculture, par M. le Compte Chaptal.

But, although certain earths in their separate state have a greater power of absorption than others, it does not follow that a soil consisting chiefly of that one earth would possess a greater power of absorption than a soil composed of a mixture of earths, even though these earths should in themselves be less absorbent. Thus, a soil consisting chiefly of aluminous earth, though alumina is itself the most absorbent of all the earths, taking water up in the greatest quantity when poured upon it, as well as retaining it the longest, is not really so absorbent as when it is mixed with other earths. Hence, the stiffer clays are not the soils which absorb water readily from the atmosphere. Such soils, when the weather is dry, become indurated upon the surface, which presents an obstacle to absorption; and thus we find, that the vegetation of very stiff clays is almost as soon injured by drought as that of sandy soils, and much more quickly than that of good loams.

A mixture of siliceous sand, then, with a very aluminous soil, although the sand is the less absorbent substance of the two, increases the general power of absorption from the atmosphere; so also does a mixture of lime, and, in an eminent degree, of animal and vegetable matter.

It is not, then, the prevalence of any one earth that constitutes a soil well fitted to absorb humidity. A mixture of certain proportions of alumina and silica, of carbonate of lime, and of vegetable and animal matter, appears to be the best suited for absorbing the humidity of the atmosphere, of preserving it, and transmitting it the most regularly to the plant.

Neither is the prevalence of any one earth in a soil favourable to its general powers of production. Too great a proportion of alumina forms a soil too stiff and tenacious. Such a soil will, from this cause, be found to be unproductive. A soil consisting of carbonate of lime only, as we see in the case of chalk, is a bad soil. A soil consisting of alumina and carbonate of lime only, as we see in the case of clay-marl, is unproductive as a soil, until mixed with other substances. A soil consisting chiefly of silica, is often so barren as to be incapable of sustaining vegetation at all.

Some, founding on the experiments of Sir Humphry Davy, have been led to the opinion, that the fertility of soils is directly indicated by their power of absorbing water from the atmosphere, and that their relative fertility may be estimated by this circumstance alone. Sir Humphry Davy compared together the absorbent power of various soils with respect to the moisture of the atmosphere, and found it to be the greatest in the most fertile. Thus, 1000 parts of a very fertile soil from the banks of the river Parret in Somersetshire, when dried at 212°, gained in an hour, when exposed to air saturated with moisture at the temperature of 62,° 16 grains.

1000 parts of a soil from Mersea in Essex, worth 45s. an acre, gained, under the same circumstances, 13 grains.

1000 parts of a fine sand from Essex, worth 28s. an acre, gained 11 grains.

1000 parts of a coarse sand, worth 15s. an acre, gained only 8 grains.

1000 parts of the soil of Bagshot-heath gained only 3 grains.

It is an error, however, to hold that the relative fertility of soils may be determined by their power under the circumstances mentioned, to absorb moisture from the atmosphere. Peat-earth is a very absorbent soil, but it is not a soil of great fertility. To infer that the fertility of soils depends upon their powers either to absorb or to retain moisture, were to reason as if these were the only conditions of fertility in soils, which does not appear to be the case; and other experiments accordingly do not bear out the conclusion that the fertility of soils depends upon these properties. But this may be inferred, that all productive soils have a considerable power of absorbing moisture and retaining it when so absorbed, and that this property does not depend on the prevalence of any one substance, but on a mixture of several substances.

It has been found also, we have seen, that the fertility of soils, however produced, is not dependent on the prevalence of any one mineral in the soil, but on a mixture or combination of several. But what the precise proportion of these is which is most favourable to fertility has not yet been determined.

Without detailing any of the numerous experiments of chemical analysis that have been made, with the design of ascertaining this and other points relating to the properties of soils, the following conclusions may be given as apparently deducible from the investigations that have taken place :—

1. Soils in which a large quantity of silica and alumina exists in the state of fine division, are comparatively fertile.

2. Soils in which the quantity of siliceous sand is large are comparatively infertile ; while soils in which the sand is fine and only partially siliceous, are comparatively fertile.

3. Iron exists in all soils, but does not influence their fertility in proportion to its larger or smaller quantity.

4. An excess of the acid combinations of the oxide of iron, and certain other saline bodies, is hurtful to vegetation.

5. Carbonate of lime exists in the best soils, and, generally, though not always, in larger quantity in the better than in the inferior soils.

6. Certain earths possess the power of combining chemically with animal and vegetable matter, and of retaining it for a longer or shorter time. Thus, alumina and lime form certain compounds of greater or less insolubility with animal and vegetable matters, while silica will not enter into the same combinations ; and hence it is that aluminous and calcareous soils retain for a longer time the manure applied to them than siliceous soils.

7. When water is in excess in the soil, and when vegetable matter is present, acid is formed which is injurious to the productive powers of the soil. Farmers are familiar with this effect, and say that the soil is soured.

8. Soils, besides absorbing moisture from the air, appear to absorb carbon and other matters nutrimental to plants.

These are the principal results to which the chemistry of agriculture has conducted us with respect to soils. This branch of science, however, may be said to be as yet imperfect, and a large field of useful investigation still remains for the philosophical inquirer. Although it may be said that much has not been done with relation to the really useful, which observation and practice had not before shown, yet we have at least escaped from the errors of former opinions, and so far the path of further inquiry is more open to us.

Amongst other results to which this species of investigation has conducted us, we have seen—that the practice known to agriculturists of mixing together different kinds of earths, admits of explanation on principles founded on our knowledge of the composition of soils: that the beneficial action of manures depends upon a proper constitution and texture of the mineral portion of the soil, and that hence to derive the full benefit of manures, the province of the cultivator is to improve the texture and constitution of the soil: that the comminution of the component parts of the soil is beneficial, as rendering the whole more pervious to the air, and the vapour, and other matters, with which the atmosphere is charged: and further, we have been enabled to render our common nomenclature of soils more precise, by distinguishing them by the terms Siliceous, Aluminous, Calcareous, Magnesian, and Ferruginous, as silica, alumina, lime, magnesia, and iron, prevail in their composition.

We might now proceed to consider the relation existing between the soils of a country and its geological condition. This is a subject interesting to the scientific agriculturist. But, however curious the investigation might prove, it is not necessary for that practical illustration of the subject of soils, which consists with the design of this work. Besides, to characterize the quality of soils, as affected by the geological nature of the country or district, is to view the subject in a somewhat more extended manner than is consistent with the common purposes of the farmer. Although it is found that a relation may be generally traced between the nature of the rocks of a country or district, and its fertility—as, in the British Islands, between the new red sandstone and the finest districts of the country; between the coal-formation, under certain circumstances, and a ferruginous and somewhat ungrateful soil; between the magnesian limestone and a tract of comparative infertility; between the lias formation and one of comparative productiveness, and so on—yet many degrees of quality may exist in the soils of the same series of rocks, and in the same country; and even all the contrast between great fertility and great barrenness may be found within the limits of a single field. We must, therefore, narrow our views when we examine the soils which we have occasion to cultivate, and regard, not their properties with relation to an entire district, but their minuter shades of fertility and character.

We have thus considered their properties as determined by their external characters, and in part by their chemical composition. We may now consider their characters as determined by their vegetable productions.

III. THE PROPERTIES OF SOILS AS DETERMINED BY THEIR VEGETABLE PRODUCTIONS.

When we regard the distribution of plants in different regions, we perceive that this is determined by causes which have little relation to the nature of the soil on which the plants grow. The soils of all countries are, in their essential characters, alike. The same mineral masses, composed of the same substances, exist over all the world, and yield, by their disintegration or decomposition, the same materials for the forming of soils.

But, although the mineral matter of the soils of all countries is thus similar in its constituent parts, it is altogether different with the vegetation by which these soils are characterized. Every zone, from the equator to the polar circle, is distinguished by a different vegetation, and different regions have their peculiar plants. A district of granite, of sandstone, or trap, in southern Asia, will yield the same materials for forming soils as similar districts in northern Europe, while the vegetation produced will scarcely possess any common character.

Amongst the natural causes which affect the vegetation of countries, the influence of temperature is that which is the most obvious to the senses. When we pass from a warm country to a cold, we perceive a change in the whole character of the vege tation. We cannot ascend a mountain without finding such a change in the kinds of plants produced, and in the vigour with which they grow, dependent upon the change of temperature. The degree of moisture, too, the distance or proximity of the sea, and other circumstances connected with the climate and physical condition of the country, affect the nature of its vegetable productions, and show, that the influence of soil, with respect to the kind of plants produced, is entirely subordinate to that of temperature and the effects of climate.

When we extend, then, the range of our observation to different and distant countries, we see that the nature of the plants cannot indicate that of the soils on which they grow. It is only within narrow limits, and under given conditions of climate, that the kinds of plants afford any indication of the nature of the soils which produce them.

Within certain geographical limits, however, as those of a country having throughout nearly the same climate with respect to temperature and humidity, useful rules may be given for distinguishing soils by means of the plants which they produce. Numerous species of plants, indeed, will grow, with equal readiness, on different kinds of soils; yet there are other species which affect particular soils, and in their wild state do not grow on any other. Thus, there are plants whose natural habitat is peat, others which grow on soils charged with moisture, and others on soils which are dry; some which, under the like conditions of humidity and temperature, are proper to the light and siliceous soils, some to the stiff and aluminous, some to the calcareous.

But, as even within the limits of a single country, pretty similar in its climate throughout, variations must exist of altitude, and, consequently, of temperature,—of exposure to particular winds, and, consequently, of humidity,—of proximity or distance from the sea, and other circumstances affecting the habitats of plants,—it is often difficult to indicate the precise nature of a soil merely by its prevailing vegetation. It is almost always possible, however, to determine from this circumstance, whether the soil be wet or dry, and whether it be fertile or infertile.

It is for the last-mentioned purpose, namely, determining the character of a soil with respect to its fertility, that the examination of its vegetable produce is the most important in practice. The nature of a soil, with regard to its texture and composition, will generally be best determined by an examination of the substance itself. But its fertility, or power of production, may be judged of from its natural produce; in part from the kinds of plants which are peculiar to it, and in part from the luxuriance with which they grow.

When we cast the eye over a tract of country, we have generally little difficulty in determining whether this tract be barren or fertile. The general aspect of the vegetation, whether stunted or vigorous, the absence or presence of heaths, the richness of the sward, the cleanness and straightness of the stems of trees, the verdure of the foliage, and the like, present to the eye a general character not readily mistaken.

When we observe a tract covered with luxuriant grasses and other plants, and with vigorous shrubs and trees, we naturally associate these appearances with fertility in the soil itself. When, again, we see a tract of heaths or naked sands, with the plants small or sickly, the soil thinly covered with lichens, mosses, and other inferior plants, the eye alone is sufficient to indicate that the tract is absolutely or relatively infertile.

The same method of judging of the productiveness of the soil may be extended to a field or to a farm. Let us direct the eye over it, and its general character with relation to its vegetable productions, will impress us at once with an idea of its fertility or barrenness.

This conclusion, indeed, will not be so securely arrived at if the surface be limited to a single field, and still less if that field shall be cultivated, in which case the effects of art, and the stimulus of cultivation, may disguise the natural characters of the soil. But if the range of our observation shall be so extended as to take in a sufficient number of fields and objects, as trees, shrubs, hedges, and natural meadows, we shall scarcely fail, if the eye be at all accustomed to country objects, to arrive at a tolerably correct conclusion as to the general character of the soil with respect to fertility; and our conclusions will be yet more satisfactory and precise, if we know the particular kinds of plants which thus give the character of infertility or productiveness to the soil.

The plants the most important in this species of examination are the heaths, the grasses, and other herbage plants. In the vast forests of the New World, a common method resorted to by settlers for judging of the comparative productiveness of soils, is by observing the kind of trees produced, whether pine, cedar, hickory, or oak. This is because the principal vegetable productions of these countries are wood. But with us the principal vegetable productions are the heaths, the grasses, and other plants that form the sward. These may be said to cover the entire surface of the country when not extirpated by art; and they afford, accordingly, the readiest means which vegetable productions present of judging of the properties of soils.

The fertility of soils, generally speaking, is denoted by their power to yield the useful plants; and it is a law, with few exceptions, that the poorer the soil is, the less nutritious are the plants which, in its natural state, it produces. The soils of the poorest class produce mosses, lichens, and heaths, which are less nutritious than the grasses. As the soil improves in quality, the grasses become intermixed with the heaths, lichens, and mosses. But the grasses are still inferior and little nutritious. As the soil continues to improve, the grasses become more valuable in their kind, and more numerous in their species; and, in like manner, the leguminous and other herbage plants indicate, by their kinds and greater numbers, the increasing fertility of the soil. A square foot of rich old turf has been found to contain 1000 separate plants of twenty distinct species *; while a square foot of siliceous sand will

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* Hort. Gram. Woburnensis.

frequently contain not more than half a dozen distinct plants, and those a single species.

In the northern latitudes of Europe, the plants most generally regarded as indicative of inferior soils are the heaths. Some of the species of this family characterize, in a peculiar manner, the soils termed peaty. They are found, too, abundantly, on the coarser clays or tills, on the poorer siliceous sands, as those lying upon or derived from quartz, on the poorer class of calcareous soils as chalk, and generally on all soils low in the scale of fertility.

The soils where this kind of plant prevails, are frequently termed heathy soils or heaths. Heathy soils have, however, their relative degrees of productiveness, and this is generally well denoted by the vigour with which the heaths peculiar to them grow. Thus, a soil of stunted heaths may be regarded as amongst the lowest in the scale of fertility, whilst a vigorous growth of the plant may indicate a soil susceptible of improvement and cultivation.

The principal heaths of this country are :—

1. Calluna vulgaris—Common Ling ;
2. Erica cinerea—Fine-leaved Heath, indicative of a dry soil ;
3. Erica Tetralix—Cross-leaved Heath, indicative of a wet soil ; and two other species more rare and local.

Intermixed with heaths, and indicating like them, soils low in the scale of fertility, are numerous plants. Such are :—

1. Many species of Lichens, as—
   Cladonia rangiferina—Rein-deer Moss, and
   Cetraria islandica—Iceland Moss.
   Which two species form an exception to the more common law, by being nutritive, though produced on inferior soils.
2. Empetrum nigrum—Black Crowberry or Crakeberry.
3. Salix fusca—Dwarf Silky Willow.
4. Lycopodium clavatum—Common Club-moss.
5. Genista anglica—Needle Greenweed or Petty-whin, &c.

And many of the inferior grasses, as—

1. Melica cœrulea—Purple Melic-grass.
2. Nardus stricta—Mat-grass.

3. Agrostis vulgaris—Fine Bent-grass.
   And various Carices and Junci,—plants of an inferior kind, with respect to their nutritive powers.

All these species of plants indicate soils low in the scale of fertility.

But although peaty soils produce these and other inferior herbage plants, yet there are plants still more distinctive of *this class of soils, and which, growing only upon it, may be* said to be the true plants of peat. Such are—

1. Certain species of Sphagnum, of which the most common are:—
   Sphagnum obtusifolium—Blunt-leaved Sphagnum.
   Sphagnum acutifolium—Sharp-leaved Sphagnum.
   It is by the decay of these species, that the great mass of peat appears to be formed in certain countries.
2. Eleocharis cæspitosa—Scaly-stalked Spike-rush.
3. Polytrichum commune—Common Polytrichum.
4. Different species of Eriophorum or Cotton-grass, namely—
   Eriophorum vaginatum—Hare's-tail Cotton-grass.
   Eriophorum polystachion—Broad-leaved Cotton-grass.
   Eriophorum angustifolium—Common Cotton-grass.
5. Narthecium ossifragum—Lancashire Bog-asphodel, &c.

These and other plants growing only on peat, indicate great infertility.

Another class of plants indicating extreme dryness of the soil, also consists of plants denoting infertility. Such are—

1. Galium verum—Yellow Bed-straw.
2. Galium saxatile—Smooth Heath Bed-straw.
3. Campanula rotundifolia—Round-leaved Bell-flower or Hare-bell.
4. Aira præcox—Early Hair-grass.
5. Aira caryophyllea—Silvery Hair-grass.
6. Aira cristata—Crested Hair-grass.
7. Arenaria rubra—Purple Sandwort.
8. Hieracium Pilosella—Common Mouse-ear Hawkweed.
9. Linum catharticum—Purging Flax.
10. Rumex acetosella—Sheep's-sorrel.

There is also a class of plants which indicates wetness of the soil. These plants, however, do not necessarily indicate infertility, because, in numerous cases, soils, though charged with moisture, are naturally fertile. Of the first kind, namely, those indicating infertility, as well as moisture, the following are examples :—

1. Juncus squarrosus—Heath-rush.
2. Juncus acutiflorus—Sharp-flowered jointed Rush.
3. Lychnis Flos-Cuculi—Meadow Lychnis or Ragged Robin.
4. Ranunculus Flammula—Lesser Spearwort.
5. Cnicus palustris—Marsh Plume-Thistle.
6. Cardamine pratensis—Common Meadow Lady's-smock.
7. Pinguicula vulgaris—Common Butterwort.
8. *Pedicularis sylvatica—Pasture Louse-wort or Dwarf Red Rattle.*
9. Triglochin palustre—Marsh Arrow-grass.
10. Galium palustre—White Water Bed-straw.
11. Rhinanthus Crista-Galli—Common Yellow Rattle.
    And various species of Carex, &c.

The plants which have been mentioned, indicate infertility and wetness of the soil: others show that the soil is wet, but do not necessarily indicate that it is infertile. Such are :—

1. Agrostis alba—March Bent-grass or Fiorin.
2. Poa fluitans—Floating Meadow-grass.
3. Poa aquatica—Reed Meadow-grass.
4. Arundo Phragmites—Common Reed.
5. Alopecurus geniculatus—Floating Foxtail-grass.
6. Catabrosa aquatica—Water Whorl-grass.
7. Equisetum arvense—Corn Horsetail; and other species of Equisetum.
8. Veronica Beccabunga—Brooklime.
9. Polygonum amphibium—Amphibious Persicaria.
10. Stachys palustris—Marsh Woundwort.
11. Juncus effusus—Soft Rush.
12. Juncus conglomeratus—Common Rush; and many other species of plants.

Certain plants are held to indicate infertility where they prevail, without being peculiar either to a very wet or very dry situation. Such are :—

1. Euphrasia officinalis—Eyebright.
2. Prunella vulgaris—Self-heal.
3. Aira cæspitosa—Turfy Hair-grass.
4. Triodia decumbens—Decumbent Heath-grass, &c.

Certain plants indicate a maritime situation. Such are :—

1. Ammophila arundinacea—Common Sea-Reed or Mat-weed.
2. Carex arenaria—Sea Carex.
3. Elymus arenarius—Upright Sea Lyme-grass.
4. Triticum junceum—Sea Rushy Wheat-grass.
5. Statice Armeria—Thrift or Sea Gilliflower, &c.

Various plants are regarded as indicating fertility where they prevail. Of these are :—

1. Cnicus lanceolatus—Spear Plume-Thistle.
2. Urtica dioica—Great Nettle.
3. Arctium Lappa—Common Burdock.
4. Stellaria media—Common Chickweed.
5. Achillea Millefolium—Common Yarrow.

And generally speaking, all the richer and more nutritious pasture grasses. Such are :—

1. Dactylis glomerata—Rough Cocksfoot.
2. Festuca pratensis—Meadow Fescue.
3. Alopecurus pratensis—Meadow Foxtail.
4. Poa trivialis—Rough-stalked Meadow-grass.
5. Lolium perenne—Ryegrass.

hose who desire to pursue this investigation more in detail, may consult botanical works, descriptive of the plants of particular countries or districts, in which they will find the habitats of plants indicated with more or less correctness. It is not necessary, in the present place, to extend the observations on this subject; for in giving examples of plants, those have been selected which are of frequent occurrence, and the best suited to indicate the characters of soils in this country.

I shall now conclude the subject of soils, by giving a few rules for enabling the student to distinguish soils in the situations in which they may be presented to him.

First, then, let him make such use of the indications afforded by the natural produce of the soils as his means of information afford. He may not know the names of the plants that are growing naturally upon the surface, but he can always observe whether they are growing with vigour, whether the sward is thickly covered with species, and whether the general aspect of the part to be examined indicates fertility or poverty.

A difficulty, which it will be well that he endeavour, in the first place, to overcome, is to distinguish the peaty soils from the earthy. He will experience little difficulty in this when they are distinct from each other, and covered by their natural herbage. But when they are subject to cultivation, or intermingled with the earthy soils of the same field, or when a soil contains a certain portion of peat in its composition without being entirely peaty, then the eye may be deceived, from their resemblance to the dark-coloured loams. The one class of soils, however, may be of great fertility, and the other of great barrenness: for it is to be observed that, though peat may be often rendered fertile, its presence in soils is always suspicious.

The soils termed peaty, it was before observed, are dark in their colour, and loose and spongy in their texture, even when improved by art. The soils which they most resemble in external characters are the richer loams, but they are more light and spongy than these, and their colour is of a duller dark than the loams, which approach rather to a hazel hue. Peaty soils, too, very generally lie on a retentive subsoil; but perhaps the best method of discriminating them in the absence of their peculiar vegetation, is by the stones which lie upon their surface. These appear to be acted upon by the acid matter of the peat, and present a white appearance, which, when once observed, will not be easily mistaken again. Coupling this indication with the dull black, as distinguished from the brighter hazel of the loam, and, above all, with the peculiar vegetation and steril aspect of the surface, an observer will soon learn to distinguish the peaty soils from the earthy.

In examining the earthy soils, an essential circumstance to be regarded is, the depth of the soil and the texture of the subsoil. A medium depth of a soil may be held to be from ten to twelve inches. But it will be better that it exceed a foot, and this greater depth of the soil is always a favourable indication. If the depth of the soil does not exceed six inches, that is an unfavourable indication. Such shallow soils are rarely good, except sometimes when they occur resting on peculiar rocks, as compact limestone, and certain easily decomposed basalts and porphyries. If a shallow soil shall occur on a retentive clay, or on siliceous sand, we may certainly pronounce it to be bad. When in the common operations of tillage the plough is constantly turning up a subsoil very different in colour from the upper stratum, that is an unfavourable indication.

When we find the rain in a furrow of ordinary descent carrying off the soil, and leaving the subsoil exposed, that is an unfavourable indication. It is desirable to see the water in the furrows sink down, and be absorbed, instead of carrying off the surface soil.

If the soil be of a dull black colour, and if it present upon the surface the white stones above referred to, that is an unfavourable indication, as it shews that the soil has more or less of peat in its composition.

If the soil produce sub-aquatic plants, it is wet. If we find that such a soil is peaty, or shallow on a retentive-subsoil, it is naturally steril. If we find that the sub-aquatic plants are tall and vigorous, and the soil earthy and deep, the removal of the wetness may remove the cause of infertility, and such a soil may become of the richest kind.

If we find a soil producing naturally the superior herbage plants, and of a good depth, that soil we may infer to be good. When soil of this kind tends to a dark hazel colour, we may safely reckon it amongst the superior soils.

By attention to these rules, and by a little observation and practice, the difficulty of discriminating soils will gradually be lessened, and at length disappear. Those who have been used to country objects rarely experience difficulty in discriminating soils, in so far at least as these soils are to be distinguished by their texture, into stiff and free, or by their powers of production into rich and poor.

IV. MEANS OF INCREASING THE PRODUCTIVE POWERS OF SOILS.

The means at our command of increasing the productive powers of soils may be comprehended under the following general heads :—

1. Supplying to the soil those organic and earthy substances which may be required.
2. Altering its texture, depth, and properties, by tillage and other means.
3. Changing its relation with respect to moisture.
4. Changing its relation with respect to temperature.

Vegetable and animal matters, in a decomposing state, appear to act in various ways in increasing the productive powers of the soil. They improve its texture, and they may be supposed to increase its power to absorb and retain moisture ; but above all, they supply that matter, which, in whatever form conveyed to the organs of plants, tends to nourish them. This matter being absorbed by the roots of the plants, it must be supplied when exhausted.

Experience has in every age accordingly taught the husbandman to supply those substances to the soil ; and the doing so forms one of the most important means at his command of maintaining or increasing its fertility.

Besides the animal and vegetable matter which is mixed or combined with the mineral part of the soil, and is essential to its productiveness, the mineral parts themselves, it has been seen, require to be mixed together in certain proportions, and in certain states of division, in order to produce the greatest degree of fertility.

Silica and alumina form the principal mineral part of the soil. If one or other of these earths be in excess, the soil is defective in its composition. If the alumina prevail, the soil is too adhesive ; if the silica prevail, it is too loose. A medium is seen to be the best ; and although the precise proportions in which the alumina and silica should exist have not been determined, it is safer that there be a tendency to an excess of alumina than of silica. Further, the fertility of the soil depends on the state of mechanical division of these minerals.

It would appear, then, to be a mean of improving the composition of a soil, to add to it siliceous matter when it is found to be too stiff, and aluminous matter when it is found to be too loose; and, further, to reduce these substances to their greatest degree of mechanical division.

Sometimes, accordingly, we have the means of improving the constitution of soils, by mixing sand with clay, or clay with sand. But, in practice, the direct mixing of these two substances for the purpose of producing a soil of better texture is rare; *first*, because the expense of this species of improvement is considerable; and *second*, because, in the state in which sand and clay are usually available for this purpose, it seldom happens that the aluminous matter of the one, or the siliceous matter of the other, is in that state of minute division which is favourable to fertility.

It is otherwise with the earth lime. This can, in all cases, be reduced by heat to that state of minute division which is favourable to the productiveness of soils; and hence it can always be applied with benefit to those soils in which it is wanting.

Lime is sometimes mixed, in its natural state, with aluminous and siliceous matter. It then forms marl, a substance which is frequently applied to soils to improve them. It is chiefly to the lighter soils that marl is suited; for then, not only is lime supplied, but alumina, which improves the texture of the soil. It is by means of this mixture that some of the greatest improvements on siliceous sands that have taken place in Europe have been effected.

There are cases in which even calcareous matter is in excess in soils. This occurs especially in districts where the chalk formation exists. When the earthy stratum resting upon the chalk is very thin, the chalky matter becomes mixed with it, and being then in excess, forms a barren soil.

An obvious method of amending the composition of a soil of this kind is by adding any of the other earths, whether siliceous or aluminous. We need not here scruple to apply them, because the clay is coarse or the sand gritty. We may add them in almost any form in which they can be conveniently procured; for the effect will be to improve the composition of the soil.

There is another case in which, in like manner, siliceous and aluminous matter may be applied directly in almost any state in which they can be found. This is in the case of peat. Here the vegetable matter is in excess, and the addition accordingly of any of the earths is an amendment of the composition of the soil.

We see, then, that the composition of soils may be improved by the addition of animal and vegetable matter, and also, in many cases, by the addition of those earths in which they may be deficient, and, in an especial degree, of lime, which we can always apply in the form of minute division best suited to improve the composition of the soil. This is the first of the means referred to of adding to the productive powers of soils, and will be considered in detail under the head of Manures, and other branches of the management of the farm.

The *second* mode referred to of increasing the productive powers of soils, is that of altering their texture, depth, and properties, by tillage and other means.

The mere effect of that comminution of the parts of the soil which it undergoes in the common operations of tillage, is seen to have a beneficial influence on the productive powers of the soil. Whether the soil imbibes from the atmosphere anything besides aqueous vapour or not, it is known that the exposure of the matter of the soil to the atmosphere, and the comminuting of its parts by tillage, add permanently to its fertility. Thus we learn from experience the good effects of tilling lands well. Soils once tilled are rendered for the most part more productive by the process. Peaty turf, if suffered to remain in its original state, may continue to produce nothing but heath and the most useless plants; but, if merely ploughed, and exposed to the influence of the atmosphere, it will at once tend to produce grasses of a better kind, and of greater variety; and, again, if a subsoil of coarse clay be exposed to the atmosphere, it is generally at first very unproductive; and it is not until after long exposure, that it becomes productive. This is most remarkable in the case of clay-marl, a substance in itself containing the materials of a fertile soil, but which is often barren, until after pulverization and the influence of the atmosphere.

It is, indeed, conformable to analogy, as well as to experience, that soils should be improved by pulverization and exposure to the atmosphere. In our examination of the constituent parts of soils, we have seen that their fertility is in a great degree indicated by the proportion of minutely divided earthy matter which they contain. The effect of tillage, therefore, may be reasonably supposed to promote this division, both by the mechanical action of our instruments, and by exposing the particles of the soil to the action of the air.

Another purpose sometimes promoted by tillage, and subservient to the amendment of the soil, is the deepening of the upper stratum.

The subsoil, it has been seen, is distinguished from the soil properly so called, by the former containing less vegetable and animal matter, and so being less suited to the nourishment of plants; and in certain cases it is even found to be injurious to vegetation. It is generally important, however, that there be a good depth of soil; and thus it is often expedient for the effecting of a permanent improvement of the surface, to plough up and mix with it a portion of the subsoil, even though that subsoil should be in itself infertile.

These, then, are the principal mechanical means by which we can improve the soil, and they will be considered in detail under the various heads which relate to the operations of tillage.

Another mean, indeed, of changing the composition of soils, is incineration, commonly called *paring and burning*. This process will be described as connected with the operations of *tillage, and may be considered as one of the means possessed by us of adding to the productiveness of soils.*

The *third* mode referred to of increasing the productive powers of soils, is changing their relation with respect to moisture.

In warmer countries the soil is comparatively little injured by an excess of water, and more frequently suffers from the insufficiency of it. In climates like that of Britain, however, the operation of conveying away the water which is in excess is an essential one, and, if neglected, the best-devised scheme of improvement may fail. The superfluous water is either stagnant upon the surface, or percolates below it. The freeing of cultivated land from water upon the surface gives rise to the formation of land into ridges, by which the water escapes without stagnating upon the ground or sinking into the subsoil below. This is an object necessarily connected with tillage, and will be described when the manner of cultivating land is treated of.

The freeing of the soil again from that superfluous water which is contained below the surface, forms a peculiar branch of agricultural improvement, and will be described under the head Draining.

As draining is more required in the colder countries, so Irrigation, or the watering of land, is less required there than in those countries where the heat and evaporation are greater. Irrigation, however, is a curious and interesting branch of rural economy, derived by us from very ancient times. In this country it is chiefly employed in the watering of lands in grass during the months of winter and spring, and will be described when treating of the Management of Grass-Land.

The *last* of the means referred to of increasing the productive powers of soils, is by changing the relation with respect to temperature.

This mode of adding to the productive powers of soils, is less within our control than any of the others. It is only by slow degrees that we can improve the climate of a country. It is chiefly by draining, and by the rearing of hedges and wood;

all of these, accordingly, form important objects of rural economy, and will be partially treated of in this work.

The means, then, of adding to the productive powers of the soil,—*namely*, supplying the organic and earthy substances which may be required; altering its texture, depth, and property, by mechanical means; and changing its relation with respect to moisture,—will all be treated of under the different divisions of our subject; and we shall begin with that which is most closely connected with the nature and properties of soils,—the nature and properties of those substances which we apply to the soil under the name of Manures.

II. MANURES.

All substances which, when mixed with the matter of the soil, tend to fertilize it, are, in common language, termed Manures.

Manures may be composed of animal or vegetable substances; or they may consist of mineral matter; or they may be derived partly from mineral and partly from animal and vegetable substances. They may, therefore be classed, according to their origin, into—

1. Animal and Vegetable Manures.
2. Mineral Manures.
3. Mixed Manures.

In describing this class of substances, it is not my design to treat of their chemical mode of action. This investigation forms one of the most interesting parts of the chemistry of agriculture; but it is not essential to that practical knowledge of the subject which will suffice for the common purposes of the farmer. The remarks to be made, therefore, on the mode of action of these bodies, will be of a general nature.

I. ANIMAL AND VEGETABLE MANURES.

Chemical analysis shows us, that all plants, and all the products of plants, are resolvable into a small number of simple bodies, in various states of combination. These bodies are—carbon, hydrogen, oxygen, and, in smaller quantity, nitrogen or azote. These form the essential constituents of all vegetable substances. But there are likewise found in plants, though in comparatively minute quantity, certain other bodies, consisting chiefly of the four earths, silica, alumina, lime, and magnesia, of the oxide of iron, and, in small quantity, the oxide of manganese, and of the alkalies, soda, and potassa, but chiefly the alkali potassa.

Now, all these bodies, or the elements of all these bodies, exist in animal and vegetable manures; for these being animal and vegetable substances are resolvable into carbon, hydrogen, oxygen, and nitrogen, with the intermixed earthy and other bodies existing in the living plants.

In supplying, therefore, animal and vegetable substances to the soil in a decomposing state, we, in truth, supply the same substances which enter into the composition of the living plants. These substances, indeed, exist in the dead matter of the manures, in states of combination different from those in which they exist in the living vegetable; but still they are present, and must be believed to supply the matter of nutrition which the plants in growing require. Science has made known to us the truth, that the living plants and the dead manure are *resolvable into the same elementary substances*; but experience had not the less taught the husbandman in every age, that all animal and vegetable substances, mixed with the matter of the soil, tended to fertilize it, by affording nourishment to the plants which it produced.

The simple bodies which form the substance of manures exist in various states of combination. Now there is reason to believe, that, in order that the solid matters, formed by these simple bodies, may be absorbed by the roots of the growing plants, they must be dissolved in water. The absorbing pores of the roots of plants are so minute, that they are only to be discovered by powerful optical instruments. The solid bodies, therefore, which find their way into these pores, may reasonably be supposed to be held in solution by the aqueous fluid which enters into the roots of plants, and forms the sap. Water is apparently the medium by which all the matter of nutrition, in whatever form, is conveyed into the roots of plants, and without which, accordingly, vegetation is never known to take place.

Holding this opinion to be just, the substances which form vegetable and animal manures, before they can be made available as nutriment to plants, must be rendered soluble in water.

Of the means which Nature employs for this purpose, fermentation appears to be the chief. By this process, the elementary parts of the substance fermented assume new forms of combination, and become fitted to supply the matter of nutrition to plants in that form in which it can be received by the pores of the roots. The fermentative process is completed after the substance to be used as a manure is mixed with the matter of the soil; but it is common also to cause it to undergo a certain degree of fermentation before it is mixed with the earth. This is the method of preparing this class of manures for use, which is employed in the practice of the farm.

Animal matters decompose with facility when acted upon by moisture and the air, the greater proportion of their elementary parts making their escape in various forms of gaseous combination, and leaving the earths, alkalies, and part of the carbonaceous matter, remaining.

When this decomposition takes place beneath the surface of the ground, these gaseous compounds, as well as the carbon, which, when it combines with oxygen, assumes also the gaseous state, may be supposed to be partially or wholly retained in the earth, to afford the matter of nutrition to the plants.

Purely animal substances, therefore, which thus readily decompose, do not absolutely require fermentation before they are mixed with the soil. Yet even in the case of purely animal substances, certain beneficial consequences may result from subjecting them to a previous state of fermentation. Thus the urine of animals, when applied in its recent state to the soil, is not found to act so beneficially as a manure, as when a certain degree of previous fermentation has been produced.

And there is another purpose promoted by causing even pure animal matter to undergo fermentation, and this is, that, being mixed with vegetable matter, it promotes the more speedy decomposition of vegetable fibre.

Vegetable fibre is, under certain circumstances, a slowly decomposing substance. When vegetables are green and full of juices, they readily ferment; but when the stems are dried, as in the case of straw and other litter, they decompose with slowness, and the mixing them with animal matter hastens *the putrefactive fermentation. This mixing of animal with vegetable matter is the process employed for preparing the greater part of the dung of the farm-yard.*

The dung of the farm-yard is the produce of the hay, straw, turnips, and other substances used as provender or litter upon the farm. It is collected into one or more yards, and fresh litter and all other refuse being added to the mass, it gradually accumulates until it is carried out to the fields for use.

The manner of feeding cattle in their houses and yards will be afterwards explained. It is sufficient, with relation to the present subject, to observe, that the larger cattle may either be fed in stalls in close houses, or in yards in which they receive their food. When they are fed in close houses, their dung and soiled litter are carried to the heap in the yard, where it gradually accumulates; and when they are fed in the yards, their dung, in like manner, accumulates there, being in the mean time compressed by their treading upon it.

In the practice of the farm, to be afterwards especially described as suited to the circumstances of this country, the larger cattle of different kinds are brought home to their houses and respective yards before winter. Some are kept in their stalls in close houses, and their dung and soiled litter are carried out daily to the yards, while others receive their food in the yards themselves, and thus tread upon the heap. In this manner the mass of dung accumulates during the period of feeding, and at the proper period, in the following spring or summer, is carried out to the fields and applied to the land.

The dung of the farm-yard is thus seen to be a collection of animal and vegetable substances. It consists of the excrements of the animals kept and fed upon the farm, together with the straw or other materials used as litter, and generally of the refuse and offal produced about the homestead. This mixed mass is collected during the period of feeding, when it undergoes a certain degree of fermentation. When trodden by the feet of the animals kept in the yards, the effect is to exclude the external air, and to prevent the fermentative process from proceeding with that rapidity which would take place were the mass not compressed.

The principal animal substances which are mixed with the *ligneous fibre of the litter, and which cause it to undergo decomposition, are the dung and urine of the animals.*

The properties of this dung, to a certain extent, depend upon the kind of animals and the nature of their food. The dung of horses is easily fermented, and is more readily decomposable, in proportion to the succulence and nutritive qualities of the food consumed. This also holds with respect to the dung of oxen. When the animals are fed on straw and the dried stems of plants, the dung is less rich and decomposable than when they are fed on turnips, oil-cake, and other nourishing food; and the same thing holds with respect to the dung of the hog and other animals. The dung of the different feeding animals is mixed in greater or less proportion with their litter, and the greater the proportion of the animal to the vegetable matter, the more readily will the latter ferment and decompose.

The urine of the animals, again, is in itself a very rich manure, and contains, in certain states of combination, all the elements which enter into the composition of plants. It is necessarily mixed with, and partly absorbed by, the litter and other substances in the yards, and it hastens, in a material degree, the fermentation of these substances.

The urine, however, is apt either to make its escape by flowing out of the yards, or to be imperfectly mingled with the litter. It becomes, therefore, a part of the management of the farm-yard, to provide against either of these contingencies.

The farm-yard should be made level at bottom, and even paved if the subsoil be very loose and sandy, and the bottom should be sunk somewhat below the surface of the ground. As a portion of the liquid will flow from the stables and feeding-houses, gutters of stone should be made to convey the liquid from these into tanks or other reservoirs adjacent to the yards. The same means are to be taken for conveying away any excess of liquid from the yards themselves. This is not done for the purpose of draining the yards of moisture, which would be an error, but for the purpose of preventing any excess of liquid from being lost. The principal cause which produces a great flow of liquid from the yards, is an excess of rain, which, falling upon the heap faster than it can be absorbed, washes away the urine.

Three methods may be adopted for the management of the liquid which is obtained from the feeding-houses, or which oozes or is washed off from the mass in the yards.

1. It may be pumped from the tank or reservoir into which it had flowed, conveyed back to the farm-yard, and spread over the surface of the heap. In this manner, it will be imbibed by the litter, and tend to hasten the decomposition of the mass; or, if there be a compost heap upon the farm, the liquid may be spread upon it so as to be imbibed by it.

2. It may be pumped up when convenient, and conveyed in barrels to the field, and spread over the surface, a species of manuring which, under certain circumstances, is exceedingly efficacious.

3. In the bottom of the tank or reservoir to which the liquid is conveyed, may be placed absorbent earths, stems of plants, and other matters. These being saturated, will become very rich manure, and may either be carried from the tank to the field, and applied to the ground, or put into heaps or composts, until the period of using them shall arrive.

Of these methods of applying the excess of liquid from feeding-houses and yards, the most generally applicable to the common practice of farms in this country, is the conveying of the liquid back to the yards, or the spreading of it over the surface of compost heaps, or other collections of absorbent substances. In Flanders, where extreme care is bestowed in the collection and preparation of liquid manures, there is a smaller proportion of straw and hay produced on farms, than in the mixed system of agriculture of Britain. There is not, therefore, so great a proportion of ligneous fibre to be decomposed. The Flemings, accordingly, pursue the mode of managing their manure, which the circumstances peculiar to their agriculture render expedient. They can always ferment sufficiently the fibrous matter of the heap of their farm-yards, and therefore they have always a spare supply of liquid in a separate state. But in this country, where we aim at producing a large quantity of hay and the cereal grasses, we require nearly all the liquid of the feeding animals to moisten and ferment the general mass of the farm-yard.

When the animals of the farm are fed on tolerably rich and succulent food, and where the proportion of straw is not too large, there is no difficulty in fermenting the mass of the farm-yard to the degree required; but when the quantity of straw is very large in proportion to the more moist and succulent food consumed, as sometimes occurs in the case of clay-land farms in certain districts, then there may be considerable difficulty in getting the straw sufficiently fermented and decomposed for use. This may arise from the want of moisture, as well as from a deficiency of animal matter; and as we may not at the time have a power of supplying the latter, we must endeavour to keep the heap moist by soaking it, in the absence of rain, with water. But the permanent remedy for this evil is to increase the quantity of such nourishing food as the farm will produce,—namely, cabbages, tares, clovers, and other succulent and nutritive plants.

Sometimes, even when there is no extraordinary excess of dry litter, the fermentation of the heap in the yard, after proceeding to a certain degree, suddenly stops, by which the manure is much injured. This arises from the want of moisture; and when it happens it is often very difficult to renew the fermentation. The best remedy is to turn over the heap, soak it with water, and mix it with horse-dung, or any animal offal that can be obtained.

With these exceptions, the management of the farm-yard is not attended with any difficulty. We have seen that the mass consists of a collection of the excrements of the animals kept upon the farm, of the straw and other substances employed for litter, and generally of any refuse or offal produced at the homestead; and that this mixed substance is accumulated chiefly during the months of winter, undergoing during this period a certain degree of fermentation and decomposition in the yards where it lies.

The substance thus collected and partially fermented, is to be applied to the grounds during the months of spring, summer, or autumn, immediately following the winter in which it has been prepared. It should be always applied as soon after it is prepared as possible, there being a waste either in retaining it too long, or in causing it to undergo a greater degree of fermentation than is required.

In the process of the putrefactive fermentation, the elements of the body fermented, in assuming their new forms of combination, partly make their escape in the gaseous state. In the fermentation of manures, the decomposition may proceed so far that the great mass of the substance shall be exhaled, leaving behind only the earthy and alkaline, and a portion of the carbonaceous, matter of which it was composed. In the treatment of this class of substances, therefore, the putrefactive fermentation should neither be continued longer, nor carried to a greater degree than is necessary for the purposes intended.

In practice, our purpose is to produce certain kinds of crops; and certain kinds of plants, it is found, require a greater action of manures at particular stages of their growth than others. Thus, the turnip, the carrot, and the beet, which are sown, as will afterwards be seen, in the early part of summer, require that the manure applied shall be in such a state of decomposition as to act upon and nourish them in the first stages of their growth; and if this be not so, the crop may entirely fail. In these, and similar cases, accordingly, a complete preparation of the farm-yard dung is an essential point of practice.

Certain plants, again, do not require the same state of decomposition of the dung. Thus the potato requires less in the first stages of its growth than the turnip, and hence it is not necessary to subject the manure to be applied to the same degree of fermentation.

In some cases, too, as in the process of the summer fallow, to be afterwards described, the manure is mixed with the soil some time before the seeds of the plants to be cultivated are sown. In such a case the manure undergoes the necessary fermentation in the soil itself, and does not require that previous preparation which, in the case of the turnip and some other plants, is required.

But while no necessity exists for fermenting the matter of the farm-yard beyond the degree requisite for the special purpose intended, it is always a point of good practice to ferment it to that degree. In order to know when dung is sufficiently fermented for the particular use required, a very little practice and observation will suffice. When it is fully fermented, the long stems of straw which formerly matted it together, are in such a state of decomposition, that the parts can be readily separated by a fork. It is not necessary in any case that it be in that extreme state of decay in which we often see it used by gardeners, and when it can be cut by a spade like soft earth. Whenever farm-yard dung has been fermented to this degree, it has been kept beyond the proper time, and the management has been bad.

The mass, we have seen, is collected chiefly during the months of winter, and will always be ready to be applied to the ground in the spring, summer, or autumn immediately ensuing; and there is no case in which it is advisable to keep it beyond the year in which it has been collected.

A common and convenient practice is, to carry it out from the yards where it has been collected to the field where it is to be used, and there to pile it up in one or more large heaps, so that it may undergo the further decomposition required, before being applied to the land. Doubtless there is a certain waste of the volatile matter of the dung by this process, but it is frequently convenient in practice that the dung be thus carried to the field where it is to be used, so as to economize time at the season of more active labour.

When, accordingly, after the dead of winter, as towards the end of December, and during hard frosts and snows, the men and working cattle upon the farm cannot be otherwise employed, we may begin to carry out the dung to the fields where it is to be used. It is carried out in the carriages of the farm, into which it is lifted by large forks to be afterwards described. This partial carrying out of the dung from the yards proceeds when occasion offers, or when the state of the weather prevents the other labours of the farm from being carried on. And when the feeding cattle are finally removed from the houses and yards, and turned out to pasture, which, in the north of England, is generally by the middle of May, the whole remaining dung may either be carried to the fields, or remain in the yards till required for use.

The dung, as it is carried out to the fields, is to be laid in the large heaps, which may be about four and a half or five feet high, and of such other dimensions as may be convenient. When the dung is placed in these heaps, it is in a state very favourable to further fermentation; for it is to be observed, that in all cases the turning over of the dung, so as to give access to the air, causes an increase of fermentation, and this is the method adopted by farmers and gardeners when they wish to give a greater degree of fermentation to any heap. Should the dung in these large heaps not ferment to the degree required, they are to be turned over, and formed into new heaps, the upper part being placed below, and what was before below at the top. By this means the fermentative process will be renewed; and should this turning not be found sufficient, the heaps must be again turned over, so that they may be brought to the degree of decomposition required. The large heaps of this kind should not be placed in a very exposed situation, so as to be too much acted upon by winds; and it is a good precaution, and a necessary one in very warm countries, to face up the sides with a little earth or turf, and to strew some earth upon the top, so as to prevent the escape of decomposing matter. When it is wished to hasten the putrefactive process in these heaps, it is better that they be not compressed by the carriages going upon them to unload; but where there is no peculiar necessity for hastening the putrefactive process, the carriages and beasts of draught can go upon the heap without injury. When peculiar care is required, as when the dung has been imperfectly fermented in the yards, it should be spread over the heap in layers, so that one layer may undergo a slight fermentation, before it is compressed by that which is to be placed above it.

The mass may be also turned over in the yards where it lies, and allowed to ferment before it is carried out to the fields for use. In this case the workmen begin at one side of the heap, and with large forks turn it over, laying that which was before uppermost underneath, so as that the whole may be reversed. If after this process of turning, no treading of cattle is allowed, the fermentation of the mass will proceed with rapidity, and then the whole may be carried out at once from the yards to the fields for use. This method will not only in certain cases be the most convenient, but will save some of that waste of the volatile matter of the heap, which takes place under the other system.

Where the dung produced is very rich and well decomposed, as where cattle have been feeding in stalls on juicy and nutritive food, it may not appear to require this turning over to fit it for use; yet even in such a case it is generally beneficial that it be turned over at least once before being used, the effect being to ferment the mass not only sufficiently but equally, and to mix its different parts together. It may be observed also, that when the mass of vegetable and animal substances is thrown into a common yard, some care should be bestowed in spreading it equally, so that one part of the yard may not be filled with rich dung, and another with poor. The dung of horses, for example, is more susceptible of quick fermentation than that of oxen. When the stable, therefore, opens upon a common yard, the horse-dung should not be suffered to accumulate in a mass about the stable, but spread abroad upon the general heap.

Farm-yard dung is chiefly applied to the soil by being spread upon the land when in tillage, and covered by the plough. The periods at which this is done, and the manner of doing it, will be afterwards pointed out. By being covered by the earth, the dung soon passes through its course of fermegetation, and becomes decomposed, and mixed with the matter of the soil.

This valuable substance must be economised in the manner of applying it. The soil must be kept as rich as the means at the farmer's command will allow ; but it is an error in practice to saturate it at one time with manures, and to withhold them at another. They ought rather to be applied in limited quantity and frequently, so as to maintain a uniform or increasing fertility in the soil.

The produce of the farm-yard will necessarily afford the chief part of the manure consumed upon farms which do not possess extraneous sources of supply. But besides the produce of the farm-yard, there are certain vegetable and animal substances which in their separate states may be applied to the manuring of land. An example of the application of vegetable substances in this state, is, when certain plants are allowed to come into flower, and are then ploughed down in their green state, and mixed with the matter of the soil. This is a practice derived from very ancient times, and is yet followed in Italy, and other parts of Europe.

Vegetable matter, when thus covered by the soil in its green and succulent state, readily undergoes decomposition, and forms a very enriching substance. The practice, however, is chiefly suited to the warmer countries where vegetation is rapid. In colder countries, where we are able to raise green food of any kind, it is better that we apply it in the first place to the feeding of animals; for then it not only yields manure, but performs the no less important purpose of affording food.

When, however, the practice is for any reason adopted, the period at which the plants may be ploughed down is when they have come into flower, for then they contain the largest quantity of readily soluble matter, and have the least exhausted the nutrient substance of the soil. The plants employed for this purpose by the ancients were chiefly the leguminous, as the Lupine, which is still used in Italy for the same purpose. Buckwheat is also employed, and appears to be the plant best suited for the practice in northern countries, for it is easily cultivated, and soon arrives at the necessary maturity. For the same reason, Spurry has also been cultivated, but its produce is too small to render it well suited to the purpose; nay, the clovers have been thus employed at the suggestion of speculative writers even in England, and thus the error has been committed of employing a valuable article as a manure, which might have been employed in the first place in supporting the animals of the farm.

The leaves of trees also form a vegetable manure, though not a good one; for although leaves enrich, to a certain degree, the surface upon which they fall and decay, they will rarely repay the expense of collecting them expressly for manuring land. When the leaves of trees have fallen, their more soluble parts have been lost, and there remains little more than ligneous fibre with a proportion of siliceous earth.

The roots of plants disengaged from the soil in the process of tilling and cleaning it, are also employed as a vegetable manure. Some of these, however, as the couch-grass, being very vivacious, would readily spring again; and therefore it is necessary that their vegetative powers be destroyed, which may be done by mixing them with lime, and forming in this way a compost. Many farmers, however, to save time, or to prevent the risk of the plants springing again, burn them in little heaps upon the ground at the time of their being collected, and spread the ashes upon the surface. This may be sometimes convenient, but the effect is, that the principal nutritive part of the plant is dissipated, and nothing left but the carbonaceous, earthy, and other matter.

But the principal vegetable substances employed as manure in their separate state, are rape-cake, oil-cake, malt-dust, sea-weed, peat or turf in a decomposing state, and the ashes of several plants.

Rape-cake is the husk and refuse of the seed of the rape, after the oil has been expressed. It is reduced to a coarse powder, and in this state it is scattered upon the surface and lightly covered, when it attracts moisture, and readily decomposes. It is sometimes strewed upon young clovers, or it is sown with turnips and similar plants at the same time with the seeds, or it is spread upon the tilled surface of any land before the seeds are sown. The quantity that may be applied is 10 or 12 cwt. to the acre, and sometimes a smaller quantity is used. As it readily attracts moisture and is decomposed, it should be kept dry, and used in its recent state. It is better suited to land which is clayey and somewhat moist, than to that which is very dry and light.

With the Flemings this substance is a favourite manure, and they use also for the same purpose the refuse of the poppy-seed after the oil has been expressed from it. They apply these substances in larger quantity than is practised in England. They dissolve also the rape-cake in urine, and thus form a manure of the richest kind.

Oil-cake is a similar substance, being the produce of the seed of the flax after the expression of the oil. It forms likewise a very rich manure, but it is too valuable to be much used for that purpose. It is employed, as we shall afterwards see, for the feeding of animals. In North America the seeds of the cotton plant have been recently applied to the manuring of land, and found to be amongst the most fertilizing of this class of substances.

Malt-dust is used for feeding, but it is employed also as a manure. It consists of the radicle of the seed rubbed from the grain after malting. It is employed at the rate of from 40 to 60 bushels to the acre.

Sea-weed, consisting of different species of Fucus and other marine plants, is greatly used upon the sea-coasts of Great Britain and Ireland as a manure. It is very transient in its effects, but it is nevertheless of much value in situations where it can be obtained. The most convenient method of using it, is to convey it directly to the land, and apply it fresh as a top-dressing to the growing crops. If left in a heap by itself, its more soluble parts are exhaled; and a dry fibrous matter alone remains. If it is not applied, therefore, in its recent state, it should be formed into a compost with dung, or with a mixture of dung and earth.

It is more valuable for light and dry soils, and of less comparative value for the stiffer clays; and hence, when a farm has access to it, it is better to apply the sea-weed to the lighter, and the dung to the stiffer, soils upon the farm.

Sea-weed may be also burned, and its ashes applied to the soil. In this way it is largely used in Jersey and the other islands of the Channel.

Peat is a substance which may be used as a manure, but unless freed of its peculiar principles it may remain for years exposed to water and air without undergoing decomposition, in which state it can afford no nourishment to plants. Pure peat, therefore, should be made to undergo decomposition before it is applied to the soil. This may be done by long exposure to the air, or by mixing it with quicklime, which decomposes its woody fibre, and forms a kind of compost, which, however, is not greatly valued.

The woody fibre of peat may be better decomposed by mixing it with dung or any animal matter. For this purpose, the peat may be carried directly to the farm-yard, and spread upon the heap of dung, so as to be mixed equally with it. This is the most easy method of decomposing peat; but care is to be taken not to supply it in so large a quantity as to injure the quality of the manure. Peat may be decomposed, too, by mixing it in alternate layers with fresh dung in a fermenting state, the peat being first partially freed of its moisture by being for some time exposed to the air. The quantity of dung should be nearly equal to that of the peat; and when the fermentation has arrived at the degree of blood-heat, the mass should be turned over and formed into another heap; and this should in like manner be turned before being used. This species of compost, however, often disappoints expectation, perhaps from the peat still retaining some principles unfavourable to vegetation.

The ashes of wood, and all vegetables, may be used as manure; but the effects of these are for the most part not very great. By burning the plants, the carbonaceous and alkaline matter indeed remains, but the other enriching parts of the substance are expelled. In Holland and the Low Countries, the ashes of peat are extensively employed; but the peculiar value of these ashes appears to be derived from mineral impregnation. The most valued of them are taken from the low marshes of Holland, which are covered during the winter season with brackish water, and they are accordingly much impregnated with saline matter. They are sown upon the surface of growing crops of different kinds; but they are found of peculiar efficacy in promoting the growth of clover, upon the leaves of which they are strewed. They are carried far into the interior for this purpose. Some ashes, too, in England possess similar properties: but from the effects being evidently due to the saline matters with which they are mixed, they are rather to be regarded as mineral than as vegetable manures.

Of animal substances employed as manures, mention has been made of dung and urine. The first is generally mixed with ligneous fibre, and so in the common practice of this country is the latter, though urine, it has been said, may be applied in its separate state. Taking into account, however, the general economy of stock and the farm-yard in this country, it is not perhaps expedient that we should adopt the practice to any great extent: yet when any liquid manure, the excess of the cow-houses and stables, is obtained, it may be conveniently applied to grass land which is to be cut for hay or green forage.

Of excrementitious animal matter, applied in its unmixed state, one of the most useful is night-soil, a substance which is very liable to decompose. It abounds in matters composed of carbon, hydrogen, oxygen, and nitrogen, and whether recent or fermented, supplies abundantly the food of plants. In Flanders and all parts of the Low Countries, the attention paid to night-soil as a manure is very great, and it is employed in different states of fermentation according to the crops to which it is to be applied.

The disagreeable odour of this substance may be destroyed by mixing it with quicklime. When it is exposed to the atmosphere, and the layers are strewed over with lime, it soon dries, and in this state is easily pulverized. It then forms one of that valuable class of manures which may be deposited in the ground at the same time with the seed.*

Of excrementitious animal matter, too, the dung of birds is a powerful manure, though usually obtained in quantities too small to render it an object of much importance. The most generally employed is that of pigeons and domestic fowls. It should be spread upon the surface of land in tillage, and slightly covered. It may be reduced also to powder, and applied in this state in different ways.

Besides the dung of animals, their flesh and intestines are sometimes used for manures. These substances undergo a rapid decomposition when in contact with the air, and should therefore be covered by the soil before their particles have been lost by evaporation ; or they may be mixed with earthy substances and formed into a compost. This last is generally the preferable practice with regard to them, because they thus act in fertilizing a large quantity of matter with which they are mixed. The refuse of the shambles furnishes the largest supply of this kind of manure, and it is always highly valuable where it can be obtained. When animals die from accident or disease, they should never be left exposed, but be covered with earth, which they will soon impregnate with soluble matter. The disagreeable effluvia of such substances may be lessened or removed by a mixture of quicklime.

Fish forms a very powerful manure. It may sometimes be procured in considerable quantity in the neighbourhood of fishing stations. It is generally best to mix it with earth in the form of a compost. Sometimes herrings have been obtained in such quantity that they have been used in this manner, and sometimes fresh-water fishes in the shallows of fenny countries are obtained in sufficient quantity to be so employed ; and nothing can exceed the richness of this kind of manure.

Blubber may be employed very beneficially as a manure ; it should always be mixed with earthy or peaty matter, and formed into a compost.

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* Agricultural Chemistry, by Sir Humphrey Davy.

The refuse of the various manufactures in which skin, wool, and other animal substances are used, forms manure of various quality, according to the substances employed, and the nature of the manufacture; such are the refuse of the currier, the offal of the gluemaker, and various others unnecessary to be particularized.

A very important animal manure is bones. These are now used in large quantities in certain districts of this country. They had been long used in the neighbourhood of London, after having been broken down and boiled for grease. But since their more general extension as a manure, they are applied in their raw state, and form an article of considerable importation from other countries. The bones are ground, or rather they are bruised, and reduced to a coarse powder, by being passed between cylinders of a peculiar construction. Bone-mills for this purpose, driven by horse-power, steam, or water, are now in common use in England and Scotland.

Bone is composed of earthy salts, chiefly phosphate of lime, with some carbonate of lime and phosphate of magnesia, and about one-half of animal matter. But there is reason to infer, that it is owing to the phosphate of lime, that this substance owes its peculiar properties as a manure.

Bones may be applied in several ways to the ground. They may be spread upon it by the hand, or by machines constructed for the purpose, or by apparatus attached to certain sowing-machines. When deposited at the same time with the seeds, in the manner to be afterwards explained, the quantity may be 2 quarters to the acre.

Bones may be also formed into composts with earths, and thus allowed to ferment in the heap. When placed in a mass by themselves, they speedily ferment; and it is the opinion of many, that they are superior as a manure when they have undergone a previous fermentation. This may be supposed to be because they are then in a decomposing state, and so fitted to act more immediately upon the plants. But when they are reduced by grinding to a coarse powder, which they always should be, there is no necessity for subjecting them to any other fermentation than that which they will undergo in the soil itself.

Bones are less beneficial when applied to clay lands than to lighter soils, and in wet seasons than in dry. Although the quantity of the material employed is very small, it is not quickly exhausted, but extends its influence to future seasons. For the production of a single crop, an increase beyond a certain quantity is not found to be attended with any benefit; so that a small quantity is frequently seen to be applied with equal advantage as a large.

Horn is a substance of similar properties, and equally efficient as a manure; but it is obtained in very limited quantity, and its general importance is therefore greatly inferior to that of bones.

Hair and feathers are similar in their composition to horn, but they are of little importance, from the limited quantity in which they can be obtained. They are also slowly decomposable. They are of the class of manures which may be applied to trees, which require a slow and not a rapid action.

Woollen substances are also of the same chemical composition as those that have been last mentioned. They only become soluble, however, after a considerable time. Nevertheless, woollen rags form a good and lasting manure. They are to be cut in small pieces, and then spread upon the surface of the ground and covered. They are used in the hop districts for the manuring of that plant. The Genoese pick up with care in the south of France all remains of woollen stuff, that they may cause them to rot at the foot of their olive-trees. In like manner, in countries where the silk manufactures exist, the inhabitants revive the mulberry and other plants by spreading at their roots the remains of the silk-worm.

But it is not necessary to specify all the substances which can be employed as manures. The law is of general application, that all animal and vegetable substances can be used for this purpose; and the province of the farmer therefore is sedulously to collect every substance of this nature which comes within his reach, and if it does not admit of beneficial application in its separate state, to form it into a compost, or mingle it with the general mass collected in the farm-yard.

Sometimes animal manure is made to be supplied by keeping animals for a time on the same piece of ground, that their excrementitious matter may fall upon or be absorbed by the soil. This gives rise to the practice of folding, which consists in penning flocks of sheep, chiefly during the night, on a small space of ground. The pens are from time to time shifted, so that, in the course of the season, a considerable quantity of ground is successively manured. The practice is carried to a most injurious extent in some of the southern counties in England, where the sheep are driven to the fallow-ground, and penned upon it for the purpose of manuring it. The animals are even made to travel a considerable distance to the fold; and certain breeds are valued for their power to stand this rude treatment.

Where such a system prevails, we may rest assured that the farmers are ignorant of the art of collecting and preparing manures. It is the wasteful manner of applying manures, by spreading them on the surface of grass land, which prevails over the greater part of England, that produces in any case the want of this substance. Under a system of good husbandry, it is in all cases practicable so to adapt the manner of cultivation to the nature of the soil and other circumstances, that the farm shall possess the means of maintaining its own fertility by the creation of manures. And the facility in doing so is increased in an almost unlimited degree, when extraneous manures can be obtained, as must every where be the case in a rich and closely inhabited country. No necessity can exist, therefore, in any one cultivated district of this kingdom, for such a practice as the folding of sheep on arable land, merely for the purpose of manuring it.

In many parts of the Continent, indeed, from the want of enclosures, and the danger from wolves, the sheep are necessarily penned during the night. In other parts, where the chief attention is directed to the wool, and the animals are defended from the weather in houses and sheds, a considerable quantity of manure is obtained from sheep. But in England, there is no want of enclosures, nor hazard from wild animals, and the feeder never finds it for his interest to sacrifice the fattening qualities of the animal for the wool it produces; and, therefore, in all cases, the sheep ought to be suffered to pasture at large, and undisturbed. The exceptions are where they are penned on turnips and similar crops, for the purpose of consuming the plants upon the ground. Here, indeed, the sheep manure the soil in an important manner; but this is not the purpose of penning, but a consequence of it.

II. MINERAL MANURES.

The mineral substances which are employed as manures may be supposed to exert two modes of action.

1. They may act upon the soil by improving its texture, or by rendering soluble the parts of it which are insoluble; or by otherwise fitting it to promote the growth of plants.

2. They may act immediately upon the plant itself, by being received into its substance.

The manner in which this action takes place upon the organs of the plant may elude our observation; but this much may be admitted, that certain earths, oxides, and alkalies, or earths, oxides, and alkalies, combined with acids, pass into the substance of the plant, absorbed, it may be, in part, from the atmosphere, but chiefly, along with the aqueous portion of the sap, from the earth in which the roots are fixed. Some substances taken up in this latter mode, are known to act as poisons, while others exercise a beneficial action on the plant.

We cannot generally distinguish when a mineral substance acts upon the plant, through the medium of a change in the soil, or when it acts directly upon the plant itself. All that we truly know is, that certain earthy and alkaline bodies, or their saline combinations, applied to the soil, promote the growth of plants, and so, in the language of farmers, are manures.

Of all the mineral substances known to us, lime is that *which performs the most important part in improving the soil and promoting the growth of vegetables. Lime is found in* nearly all soils that are capable of sustaining vegetation, and, in combination with different acids, in nearly all vegetable substances.

Lime, as employed in agriculture and the arts, is derived from three distinct series or orders of rocks.

1. From the rocks of the primary series. These are very compact and crystalline. They afford the finest of our marbles, and yield a pure lime.

2. From the lower secondary or transition rocks. These, like the last, are hard and crystalline, and yield a lime of good quality.

3. From the carboniferous rocks, or those of the middle secondary order. It is from this source that the largest supplies of the mineral are derived. Of this series is the mountain-limestone, which is the most familiar to us, and the most generally employed in agriculture and the arts.

4. From the upper secondary rocks. In this series is the magnesian limestone, which, from its possessing peculiar properties, to be afterwards adverted to, is termed *hot-lime*, by agriculturists.

Of the same order of rocks, too, namely, the upper secondary, are the lias and oolite, which are found in some parts of England, and the lime of which is employed for agricultural purposes.

The last of the series of the upper secondary rocks is the chalk, which is found abundantly in the south-east counties of England, and in France, extending eastward through the central parts of Europe.

Limestone, from whatever series of rocks derived, when submitted to the action of heat, loses the carbonic acid with which it was united, becomes a substance of an acrid nature, absorbs water with an evolution of heat, and, by this union, forms what is termed a hydrate. In absorbing water, it crumbles down by degrees, while at the same time it begins to imbibe carbonic acid from the atmosphere. In absorbing carbonic acid, the water of the hydrate is expelled, the carbonic acid taking its place. In this manner the lime recovers the principles which it had lost by calcination. It becomes again a carbonate, without, however, having recovered its hardness and external characters. In proportion as its recomposition takes place, it loses the properties which it had acquired by calcination, ceases to be acrid and caustic, and its solubility in water is diminished.

Lime is applied to the ground either in a state of hydrate, that is, immediately after being slacked, and when it still retains its caustic properties; or in the state of carbonate, that is, after it has again absorbed carbonic acid from the surrounding medium and become mild.

When the design is to supply calcareous matter to a soil in which it is deficient, it often appears to be unimportant whether it is applied as a carbonate or a hydrate. In the latter state, however, it is more perfectly divided, and may be spread more equally upon the surface, and better mingled with the soil; and further, in its caustic state, it produces effects which it either does not produce in its mild state, or which it produces in a less degree.

Lime, in its caustic state, is observed to exercise a powerful action in decomposing the ligneous parts of plants. The same effect is indeed produced by the action of mild lime, but in a less perceptible degree.

Caustic lime, while it dissolves vegetable fibre, and renders it soluble, has also the property of forming compounds of a soapy nature with the soluble portion of vegetable and animal substances, which compounds are not dissolved till after a considerable time.

Caustic lime thus performs two functions apparently opposed to each other. It decomposes the inert vegetable matter of the soil, and then forms compounds which are not themselves readily soluble.

growing. This practice, however, though sometimes convenient, is rarely to be imitated.

4. It may be, and is most frequently, applied during the season in which the land is in fallow, or in preparation for what are termed fallow crops. The manner of applying it in these cases will be afterwards explained.

5. It may be mixed with earthy matter, particularly with that containing vegetable remains; in this case it forms a compost.

The quantity of lime applied to soils is very various, and is dependent upon the nature of the soils, the climate, and other circumstances. In warmer countries, a smaller quantity need be used than in those which are cold and humid.

The stiff clays for the most part require a larger proportion of it than the lighter soils; and in the case of such soils as contain much undecomposed vegetable matter, as peat, a quantity should be applied sufficient to decompose effectually the inert fibre.

In the north of England and south of Scotland, a moderate application of lime for the lighter soils is held to be 120 bushels heaped measure, and a medium dose for soils of different kinds about 130 bushels, though a much larger quantity than this is frequently applied in certain clay-land districts. I speak here of newly-calcined limestone; for when it has imbibed moisture and become a hydrate, it swells out to about two times its former bulk.

The periods at which doses of lime should be repeated, differ according to the quantity applied and the manner of using it. In cases where the large applications just spoken of are made, an effectual liming need not occur in less than fourteen or fifteen years.

But in other cases, lime is applied in smaller quantity, and more frequently, and there is nothing opposed to a sound theory in this practice. Nay, there is reason to infer that a more frequent application of lime, and in smaller quantity, is the most advantageous method of using it.

The application of lime calls into powerful action the nutritrient principles of the soil; and hence, if land be severely cropped after lime has been used, it is reduced to a greater state of sterility than if the stimulant had not been applied. Lime, therefore, calculated as it is to produce the best effects in fertilizing a soil, is frequently made the means, in the hands of an injudicious farmer, to injure it. This is especially observable in the case of light soils of an inferior kind. These are frequently so injured by injudicious cropping after the application of lime, that they are reduced to a state of the greatest barrenness. When soils are brought to this condition by scourging crops; they cannot be restored to fertility by a subsequent application of lime. So far from this, the future dose generally renders them more barren than before. The only good remedies are the application of vegetable and animal manures, and rest in grass.

But although the stimulating properties of lime may be abused, it is an instrument of production of the highest importance in the hands of the skilful farmer. On land improved and cultivated for the first time, it exercises a very powerful influence, and it is difficult to conceive how in many parts such land could be improved at all without the assistance of this mineral.

Lime is found to improve the quality of plants produced, to render those cultivated more productive of farine matter, and even to cause species that were not before growing naturally to occupy the ground. Thus, lime spread upon a piece of peaty land, is frequently found to eradicate in whole or in part the heaths, and to permit the grasses and clovers to take their place.

Whenever it is found advisable to deepen a soil by ploughing up a portion of the subsoil, the application of lime is the most speedy means presented to us of correcting the defects, or stimulating the productive powers, of the new substance exposed.

To admit of the beneficial action of lime, the soil should be freed of superfluous water. Not lime only, but all manures, are inefficient when the land is saturated in consequence of excess of wetness.

Lime, it has been said, may be mixed with earthy matter previously to being applied to the soil; and this is a beneficial practice. The lime in this case, is best applied in its unslacked state.

The best earthy materials for mixing with lime are those which contain a certain proportion of decomposing organic matter; such are the scourings of ditches, the sediment of pools, mud deposited by rivers and the tides, and similar substances. The lime may be applied at the rate of 2 bushels to the cubic yard, and 50 cubic yards of this mixture to the acre, will form an efficient manuring for almost any soil.

Materials for forming manures of this class are constantly presenting themselves. Old gardens, waste collections of earth, the sweepings of roads, and the like, are always to be found in more or less quantity. A mixture of lime in the proportion mentioned, will ferment these substances even when they are not peculiarly abundant in organic matter. The mass will heat, and then it should be turned over once or oftener to render the fermentation perfect, and destroy the seeds of plants which may be mingled with the substances to be fermented.

Of the rocks from which lime is derived, one of the upper secondary formation is the magnesian. It is so termed from containing a considerable proportion of magnesian earth, and is distinguished from other limestones by the effects of this substance. When the magnesia exists in a large proportion, it is found to be injurious to growing plants; and it is not until it is combined with carbonic acid, that it becomes a useful constituent part of the soil. Now, when magnesian earth is united with lime in the minerals which form this class of rocks, and when both substances are consequently calcined together, the lime having a stronger affinity for carbonic acid than magnesia, the magnesia remains longer uncombined with it than the lime. In this state it is found to burn up as it were vegetation. Hence it is termed hot lime, and is used in much smaller quantity than common lime.

Magnesian limestones are usually coloured brown or yellow. They differ from other limestones by dissolving more slowly, and with feebler effervescence, when thrown in the lump into acids. They may be distinguished by this circumstance, and by their rendering diluted nitric acid milky. The presence of magnesia in soils may be known by the waters upon the surface, which are of a whitish colour, and which lose their transparency upon the slightest agitation.

Lime, besides being used in the form of a hydrate or carbonate, is employed in agriculture in its other combinations; one of which is the sulphate of lime or gypsum.

This substance exists in soils, and is found in plants; and it is consequently supplied by our common vegetable manures. It is not, however, employed directly in any considerable quantity in this country, the success of the applications that have been made having been partial and indecisive. This, there is reason to believe, has arisen from the salt existing already in the soils to which it had been applied, in sufficient abundance for the purposes of vegetation. In other countries, it is greatly valued in certain cases as a manure, and chiefly in the case of the clovers of artificial meadows.

Gypsum, it has been said, is a compound of sulphuric acid and lime; and it contains a quantity of water of crystallization. A moderate heat deprives it of this water, and it may then be reduced to powder, and applied in that state to the soil. It may be employed, either after having undergone this process of gentle calcination, or in its raw state; but it is better that it be calcined.

The quantity applied in the countries where it is used is very small, being at the rate of about 3 cwt. to the acre. It is sown by the hand, at the time when the leaves of the clovers and other plants begin to cover the surface; and the operation is performed, if possible, during slight showery weather, it being beneficial that the leaves should be somewhat moistened, so as to retain a portion of the dust. The effect of this slight application is felt for several years.

Gypsum, though not directly applied to the soil in any con-

siderable quantity in this country, is yet indirectly applied in all our common animal and vegetable manures. Certain peat-ashes, too, owe their properties to the presence of this salt; and they are accordingly applied with good effect in the top-dressing of artificial meadows.

Lime is also found in combination with phosphoric acid, and exists in this state in most excrementitious substances, in the straw and seeds of the cereal grasses, as well as in pease, and other leguminous plants. It is also applied directly as we have seen, in the state of bruised bones, in which case, as in that of gypsum, a very small quantity of the material is required; and, what is remarkable, while a certain quantity of it will produce a given effect on plants, any excess beyond that quantity will produce no increase of effect. It would appear in this, as in the case of other saline substances, that a given quantity only is required for the uses of the plants. Nay, it appears that, when used in the quantity required, certain salts will produce a beneficial effect, while, if applied in a larger quantity, they will produce a hurtful one. Thus there is reason to believe, in the case of common salt, that while in a given quantity it is beneficial, in a larger quantity it is destructive. Even in the case of sulphate of iron, a substance regarded as eminently hurtful to plants, it appears, from experiments, that in the due quantity it is fertilizing. And this perhaps is true of all saline substances which are found in plants, not excepting the carbonate of lime itself: a certain quantity operates beneficially, while any excess beyond that quantity is not only superfluous but hurtful; in the same manner as in the animal system, certain condiments in a given quantity produce a beneficial effect, while if beyond that quantity they act as poisons.

Carbonate of lime is sometimes applied to the soil in the state of gravel and sand. Calcareous gravel is found in some places, and employed as a manure. Calcareous sand is found in various parts, chiefly of the sea coast; it is formed of broken corals and shells, and may be applied at once to the surface of the ground. When laid upon land in grass, it never fails to renovate and improve it.

Marls are another substance applied to land, and are held to be valuable in proportion to the calcareous matter which they contain.

Clay-marl, as it is termed, is composed of carbonate of lime, silica, and alumina, with a portion of the oxide of iron or manganese. It occurs in beds, and is extensively diffused. It assumes a considerable diversity of aspect and character, as it is more or less indurated, or as the calcareous or aluminous matter prevails. When very indurated, it is frequently termed rock-marl.

The operation of marls is more slow than that of lime, and they require to be applied in comparatively larger quantity. They should be laid upon the surface, and generally well exposed to the influence of the atmosphere before being mixed with the soil. Some marls have been found to be very deleterious unless they had undergone this previous exposure to the air. The kinds of soils to which marls are the most beneficially applied are the sandy, gravelly, and peaty. In this case they supply calcareous matter to the soil, and improve its texture by the addition of alumina.

The quantity of this substance applied is exceedingly various, being dependent upon the nature of the soil, and the proportion of calcareous matter in the marl. Where the purpose has been to change entirely the constitution of a defective soil, it has been applied even at the rate of from 300 to 400 cart-loads to the acre. But where the purpose is merely to give a common manuring, it is applied in the quantity sufficient to afford an ordinary proportion of calcareous matter. It may be laid upon the surface of land when in grass, where it remains until the land is brought under tillage; and this is generally the best method of applying it.

Shell-marl is an entirely different substance. It is chiefly a deposit of marine and sometimes of land shells, found frequently under a bed of peat. It may be used at the rate of from twenty-five to thirty cart-loads or more to the acre. It can be applied to the land when in various states, as when it is in stubble, in summer-fallow, or in grass. The latter is a good practice: for, as in the case of all calcareous matter, the application improves the herbage-plants; and the mineral, sinking into the soil, prepares it well for producing crops of corn when it is broken up for tillage. Its operation is not so quick *as that of calcined limestone,* but its effects are more lasting. *The same consequence is produced by excessive cropping after* the application of this substance as after that of calcined limestone. The soil which has been stimulated by the action of the mineral becomes more barren than before, and it is for the most part only to be restored by rest and the action of animal and vegetable manures.

The salts of lime, which have been before referred to, are the carbonate, the sulphate, and the phosphate. Magnesia has also its salts, but the only one used in agriculture is the carbonate, of which mention has been made. The sulphate has been also found in nature, and is said to have been employed beneficially as a manure; but the quantity of it is too small, and the expense of obtaining it too great, to render it of any economical importance.

The vegetable alkali potassa is found in the ashes of most plants. Wood-ashes consist in great part of this alkali, united to carbonic acid; and wood-ashes form a manure, though not one very highly valued.

Potassa combined with nitric acid, and forming the well-known substance, saltpetre, has been employed as a manure, and apparently with good effect; but these saline combinations of potassa are expensive; which is probably the great objection to the using of them; for otherwise there is reason to believe that potassa, like lime, exercises a beneficial influence upon the soil, by rendering soluble certain substances which were insoluble.

The mineral alkali soda exists in the ashes of sea-weeds; and sea-weeds we have seen form a good, though not a very lasting manure.

The muriate of soda, or, as it is more correctly termed, chloride of sodium, being the principal part of common salt, is a substance regarding the efficacy of which as a manure much discussion has taken place. Experience is entirely opposed to the application of common salt in any considerable quantity to land. The margins of the ocean, and vast saline deserts, attest the steril properties of this substance. It had been known from the earliest times that salt rendered land barren. *A salt soil was regarded by the ancients as synonymous with an unfruitful one.*

Soils abounding in salt, however, have been found to yield herbage very nutritive and wholesome, and certain saline marshes are highly valued on this account.

Salt is probably as essential to the health of vegetables as of animals, and we may believe that a mineral thus widely diffused performs important functions. It exists in all plants, is a constituent part of almost every kind of animal and vegetable manure, and is found in most soils in sufficient quantity for the purposes of vegetation.

Hence experiments with salt as a manure have in most cases failed, or been of doubtful success. That in many cases salt applied in small quantities has been useful, can hardly be questioned. These, we may believe, were the cases, comparatively rare, where there was not a sufficient quantity of salt in the soil for the uses of the plants, or where it was not supplied in sufficient quantity by the ordinary manures. Though salt can rarely be applied with advantage directly to the soil, and ought never to be applied at hazard without its being known whether the salt of the soil is really deficient, yet there is reason to believe that, in various cases, it may be applied along with other substances. Salt, in small quantities, appears to assist the decomposition of animal and vegetable matter; and a portion of it mixed with ordinary composts of earth and lime, appears to increase their fertilizing properties.

The whole subject of saline manures, it is to be observed, deserves more extended investigation than it has yet obtained. That all saline bodies which exist habitually in plants are beneficial to vegetation, we may almost from analogy infer. We see this in the case of the carbonate of lime, the sulphate of lime, and the phosphate of lime; and it is not unreasonable to infer, that all saline bodies which exist in plants in their common state, may be employed as manures.

The knowledge in which we are now deficient regards the quantity in which these substances should be applied. The carbonate of lime is that in which it appears the greatest latitude may be given. The sulphate of lime acts in smaller quantity, and so likewise does the phosphate. Common salt, supplied in small quantities in manures, promotes vegetation, while a larger quantity is injurious; and the sulphate of iron, a substance poisonous in excess, if applied in the quantity suited to the wants of plants, seems calculated to promote the vegetation of the plants, and the fertility of the soil.

III. MIXED MANURES.

This class of manures consists of those derived partly from organic, and partly from mineral substances.

Ashes or fuel of different kinds used for domestic and other purposes, may be said to be of this class. Those of coal are obtained from manufactories where much fuel is consumed, and they form a large part of the refuse of towns. Ashes of coal are to be regarded as a manure of an inferior class.

Ashes of peat are also of this mixed class. They are not generally much esteemed, though they have sometimes a peculiar value, as in the case of Dutch ashes, derived from their mineral constituents.

Soot, which may be derived from the burning of coals and wood, is frequently applied in its unmixed state as a manure. Its base is charcoal, and it is advantageously spread upon all soils, and in an especial manner upon land in grass.

The sweepings of roads are frequently used as manure, and may be always rendered capable of being so by being fermented with lime. They consist of various minerals, comminuted or ground by the action of carriages. They form mud in wet weather, and in populous countries they are much mixed with animal and vegetable matter.

Street manure, or the general refuse of towns, is a very compound substance, of much importance to the fertility of the adjacent country. It consists of all kind of offal, of the refuse of manufactories, of litter and the dung of animals, and in large quantity of ashes and other substances.

This species of manure is much valued, though it is far inferior to well-rotted dung, the produce of the farm-yard. In every town this substance ought to be carefully collected for the supply of the neighbouring country.

There is a method of increasing the quantity of manures upon a farm, which should in no case be neglected; this is by forming composts, which, as the name denotes, are a mixture of substances. If dung, or any vegetable or animal substance, be mixed with earth, the latter will imbibe a portion of the decomposing matter, and become itself fitted to be used as a manure. The earthy and the putrescent matters may be laid in layers, the earthy covering the putrescent, so as to prevent the loss of gaseous matter by evaporation. But it is not necessary to observe the precise order of layers, since the substances may be mixed together whenever they can be conveniently collected. There should be at least one heap of this kind upon a farm, as a general receptacle for all substances capable of being fermented, which may from time to time be procured. Urine poured upon such a heap will be found to be very beneficial; and lime may be mixed with it. The whole should be turned over two or more times, so as to mix the materials together and promote fermentation.

Of the nature of composts, also, are those mixtures of lime with weeds, the mud of ditches, the slime of rivers, and the like, to which reference has been already made. No opportunity should be omitted of making manures by this method.

The management of composts of all kinds is exceedingly easy. The knowledge that every sort of putrescent refuse may be mixed with earthy substances, that lime acts beneficially in fermenting the mass, that frequent turning mixes the substances together, and produces the action required, are sufficient to guide the farmer in all cases in this simple branch of farm economy. However desirable it be that the scientific agriculturist shall extend his knowledge of the nature and mode of action of the particular matters forming this class of substances, fortunately a minute knowledge of this kind is not essential to successful practice. The law, that all animal and vegetable substances whatever, and some well-known minerals, act as manures, is of such universal application, that the agriculturist can rarely have difficulty in applying the substances of this kind within his reach to their proper uses.

Having now considered the subject of the soil, and the *nature of those substances which, added to it, promote its* fertility, we are prepared to enter upon the consideration of the means which are employed to cultivate it. This forms the extensive subject of Tillage. But before treating of the details of practice, it will be proper to consider the forms and uses of the tools and machines which are employed.

III. IMPLEMENTS OF THE FARM.

In order to understand the manner of performing the labours of the farm, we should possess a certain knowledge of the mechanical agents to be employed. It is rarely, indeed, necessary that the farmer shall himself be able to construct machines, because, in most countries where the arts are cultivated, there will be a class of artisans who can supply to him the common instruments of which he stands in need. But yet it is well that he be acquainted with the principles upon which his machines should be constructed, and so be able to supply, if necessary, the want of skill in the workman.

The machines, or implements of the farm, may be divided into classes, according to the purposes to which they are to be applied:—

1. The implements for preparing land for the plants to be cultivated. These may be called the Implements of Preparatory Tillage—
    1. The Plough.
    2. The Harrow.
    3. The Grubber.
    4. The Roller.
2. Machines for Sowing—
    1. Corn in rows.
    2. Corn and Grass-seeds broad-cast
    3. The Seeds of the Bean and Pea.
    4. The smaller Seeds in rows.
3. Implements for Hoeing.
    Horse-Hoes, &c.
4. Machines for Thrashing and Winnowing.
    1. Thrashing-Machine.
    2. Winnowing-Machine.
5. Implements for preparing food for live-stock.
    1. Turnip-slicer.
    2. Chaff-cutter, &c.

6. Wheel-carriages
    1. Single and Double-horse Cart, or Waggon.
    2. Sparred or Corn-cart.
7. *Utensils of the Dairy.*
    1. *Churn.*
    2. Cheese-press, &c.
8. Implements of Manual Labour, &c.
    Barrows, Forks, Spades, Shovels, &c.

1. IMPLEMENTS OF PREPARATORY TILLAGE.

THE PLOUGH.

By means of this instrument the earth is to be turned over to a given depth; and this is to be effected by cutting from the ground successive sods or slices of earth, so that each sod or slice shall be raised up and turned over, and all the sods or slices laid resting upon one another, in such a manner as that an entire new surface shall be exposed to the atmosphere.

In the following figures, let A B C D represent the end or transverse section of the slice of earth which is to be turned over.

Fig. 1.

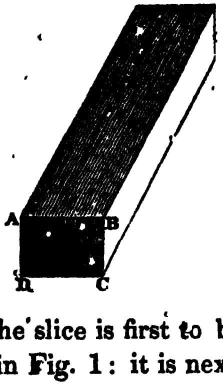


Fig. 2.

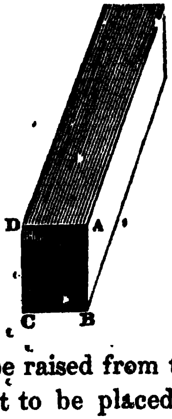
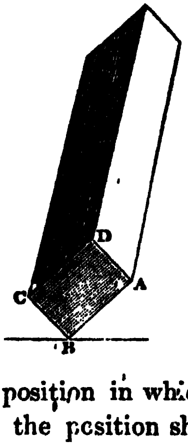


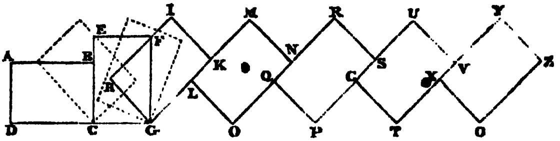
Fig. 3.



The slice is first to be raised from the position in which it lies in Fig. 1: it is next to be placed in the position shown in Fig. 2: and it is finally to be placed in that represented in Fig. 3.

In the following diagram, let ABCD, corresponding with the same letters in the last figures, represent a transverse section of the slice of earth which is to be turned over. This slice is first to be raised from its horizontal position ABCD, by being turned upon its corner C as a pivot, and placed in the position CEFG, corresponding with that of Fig. 2. It is then to be turned upon its corner G as on a pivot, and laid in the position GHIK, corresponding with that of Fig. 3. In this manner the side DC, which was formerly underneath, will be above, namely, in the position HI; and if successive slices shall be thus reversed, they will rest upon one another in the manner shown by the sections of the slices OXYZ, TCUV, PQRS, OLMN, and GHIK.

Fig. 4.



The angle of inclination at which these different slices will naturally rest upon one another in the manner shown in the figure, will depend upon the proportion which the width of the slices bears to their depth; and that the greatest extent of surface may be exposed to the air, the angle of their inclination will be 45°. In order, therefore, that the slices may be at this angle, the proportion which the width of the slices bears to their depth is to be determined: and this can be done by simple calculation; for it can be shown that the width of the slice AB being the hypothenuse of an isosceles right-angled triangle, the depth of the slice BC will be one of the sides. Supposing, therefore, the width of the sod AB to be 10 inches, the depth BC will, by calculation, be 7.071 inches*.

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* That the maximum of surface will be exposed, when the angle of inclination of the sods is 45°, may be demonstrated thus: Let the right-angled parallelogram DBMN, in the following figure, represent a section of the sod or furrow-slice, BKM being an angle of 45°, and KB being

If, then, beginning at one side of a field, we shall cut off a slice of earth, the entire length of this field, and place it in the position OXYZ, Fig. 4, and then cut off a second slice, and place it in the position TCUV, and then a third slice, and place it in the position PQRS, and so on, the various slices will rest upon each other at a given angle, in the manner represented.

A similar operation is to be performed by the plough. Beginning at the right-hand side of the field or ridge to be ploughed, a sod, which we shall now call a furrow-slice, is to be cut from the firm ground, raised up, and turned over. A second furrow-slice is in like manner to be cut from the firm ground, raised up and turned over, and so on. In this manner an entire new surface will be exposed to the atmosphere, and the

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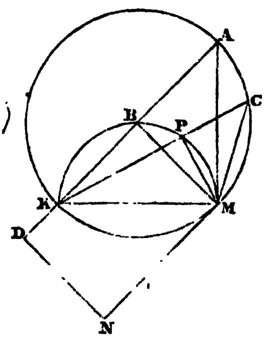
equal to BM. On KM, which is here = BD, as a diameter describe the semicircle KBM, and in that semicircle draw any other triangle KPM, representing a section of a sod having the same width as before, but with the depth PM; then will the two sides KB, BM of the isosceles right-angled triangle KBM be together greater than the two sides KP, PM of any other right-angled triangle KPM on the same base KM.

Fig. 5.

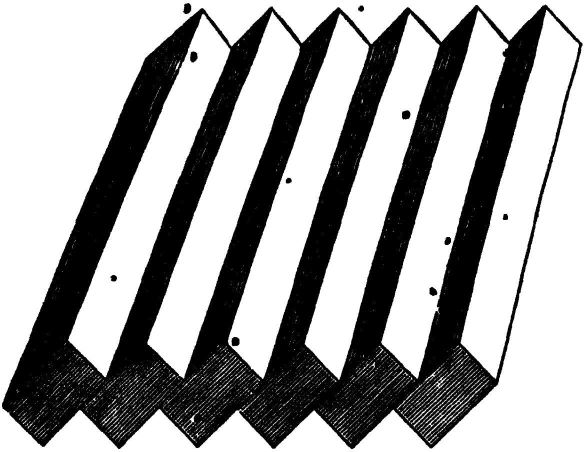


For, produce KB, and make BA = BM: produce also KP, and make PC = PM, and join AM and CM. Then, because KBM is the exterior angle of the triangle BAM, it is equal to the sum of the interior and opposite angles BAM and AMB; but BA = BM, therefore the angle BAM = AMB = $\frac{1}{2}$ KBM. In like manner, the angle KCM = $\frac{1}{2}$ KPM, But the angle KBM = KPM, and therefore the angle KAM = KCM. Hence, the segment of a circle upon KM from the centre B will pass through the points C and A; but the diameter KBA is greater than any other straight line KPC, which does not pass through the centre. Hence, since KBA = KB + BM, and since KC = KP + PM, it follows that KB + BM is greater than KP + PM.

To determine the ratio which the depth of a sod will bear to its width when the inclination is 45°—Since KBM is an isosceles triangle right-angled at B, $KM^2 = KB^2 + BM^2 = 2\,BM^2$, and consequently $BM = \sqrt{\tfrac{1}{2} KM^2}$. Hence, suppose KM, the width of the sod, to be 10, then the depth BM $= \sqrt{50} = 7.071$ as in the text.

successive furrow-slices laid resting upon one another, thus:—

Fig. 6.



A well-formed plough is that which will perform these operations with the least resistance, with the least risk of injury from the strain or shock of opposing obstacles, and which shall join to these properties such lightness and simplicity of form as are compatible with its uses.

The plough may be formed partly of wood, and partly of iron. But as, when it is formed wholly of iron, it admits of a somewhat better combination of its parts, the following figures represent it as of this material, certain parts being of malleable iron, and certain parts of cast iron.

Fig. 7. represents the plough as seen from the right-hand side, or from that side which is at the right hand of the ploughman when at work. In this position are seen the two handles A and B, by which it is guided: the mould-board DEHGF, the share HGI, the beam C, and the coulter K.

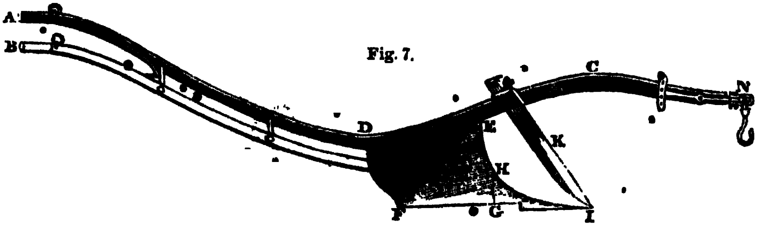


Fig. 7.

Fig. 8. represents the instrument as seen from the same side, but with the mould-board and share removed.

Here the connexion is shown of the left handle A with the beam C, of which it forms a continuation, and of the right handle B with the lower part of the frame-work. The upper ends of these two handles rise to the height of about three feet above the plane of the lower part of the plough. They are to be regarded as levers in the hands of the ploughman, for enabling him to direct the instrument.

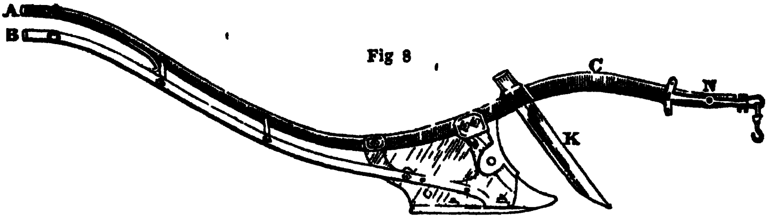


Fig 8

Fig. 9. represents the plough, as seen from the left side, being that side which, in working, is towards the unploughed land. The part AFDEB, is a perpendicular plane, formed of plates of iron. The surface of these parts, the left side of the share, FCD, and of the coulter K, should be in one plane, and move in a direction parallel to the line of draught.

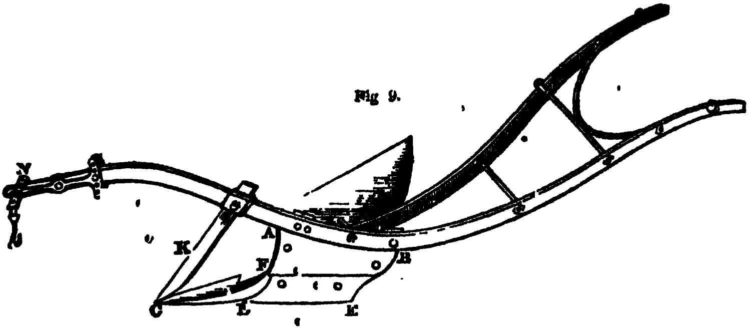


Fig 9.

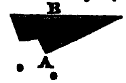
The beam is that part of the plough to which the moving power is attached. Upon the end of the beam is placed a bridle, as it is termed (N, Figs. 7, 8, and 9,) to which the point of draught is fixed, and by means of which the line of draught can be elevated or depressed, and moved to the right hand or to the left as may be required. The bridle is moveable round a bolt passing through the beam. The beam is curved in its form, in order that, being more elevated above the surface of the ground, it may be less impeded by stubble and other matters upon the surface.

In the beam is fixed the coulter K, (Figs. 7, 8, and 9). The use of this part being to cut the sod from the firm ground, previous to its being raised up and turned over, its position is inclined as in the figure, so that it may the better perform its function as a cutting instrument. The inclination of the fore part of the coulter to the plane of the plough's sole, may be 45°.

The coulter, being in front of the fore part or head of the plough, is first struck by stones or other obstacles in the ground. But a stroke upon the coulter is less apt to endanger the instrument than a stroke upon the head; and by its oblique position, when it encounters a stone or other obstacle, it tends to force it upwards out of the ground. The right side of the coulter is welded with steel on account of the greater attrition to which that part is subjected.

The share, Fig. 10, is made to be taken off, that it may be sharpened when necessary. It is formed with a wing or projecting edge to the right-hand side, which is laid with steel, on account of the friction to which it is subject. The purpose of the wing is to cut the under part of the furrow-slice, previous to its being raised upon the mould-board, by which means the operation of raising and reversing the sod is better performed, and with less waste of labour. The wing may be seven inches measured from B to A.

Fig. 10.

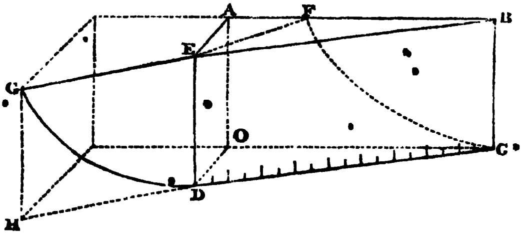


The share is formed of malleable, and the mould-board of cast, iron. The two parts combined form a curved surface, which, beginning at the point of the share I, Fig. 7, gradually rises from the horizontal plane, until it is vertical at F, at which point, accordingly, a perpendicular line would touch it from top to bottom. The surface then continues to incline in a uniform manner to the right-hand side, until, at its extreme point D, it inclines over to that side at the angle at which the furrow-slice is to be laid. The whole right-hand side of the plough, therefore, consisting of the share and mould-board, forms the curved surface of a wedge, which, from the point of the share where it is horizontal, becomes gradually more and more upright, till it is perpendicular, and then continues inclining by a uniform curve to the right-hand side, until it has formed with that side the angle at which we wish the furrow-slice to be laid. The wedge thus formed being insinuated beneath the furrow-slice and pushed forward, gradually raises it to a perpendicular position, and then, by acting upon the upper part of it, presses it over into the position in which it is to lie.

That we may better comprehend the nature of the wedge which the plough forms, let ABCDEO, Fig. 11, represent a wedge, one of whose sides, ABCO, placed perpendicularly, moves in the line of the plough's motion, and consequently corresponds with the left-hand side of the plough, and whose other side EBCD, is applied obliquely to the furrow-slice to be moved, and whose width behind, DO, is equal to the width of the sod to be moved, and which we may assume to be 10 inches. Such a wedge moved forward in the ground is calculated to move this furrow-slice to the right-hand side; but it is not calculated to raise it up and turn it over. But let the lower part of this wedge DC be supposed divided into a certain number of equal parts as ninety, then, beginning at the point C corresponding with the point of the share, let all the upper part of the wedge from the edge CD backwards, be supposed to be cut or scooped away in such a manner as that, when we measure the angle which the surface of this new wedge forms with its base, we shall find that at the first equal part or division, the inclination of the surface to the base is 1°, at the second 2°, at the fifth 5°, at the tenth 10°, and so on to the ninetieth at D, where it is 90°, or perpendicular. In this manner we shall have formed a new wedge EAFCDO, whose face

EFCD, corresponding with the right-hand side of the plough, becomes gradually more and more upright from the point C to the point D, where it is wholly upright, and so forms a uniformly-curved surface from the point to the extremity. A wedge thus formed, it is apparent, is calculated, to raise the furrow-slice in a uniform manner from its horizontal to its perpendicular position.

Fig. 11.



There yet remains, however, the further operation of pressing over the furrow-slice into the position in which it is to be ultimately laid. Now this we may suppose to be effected by lengthening out our wedge behind as from E to G, and continuing it with a uniform curvature to the right-hand side, in such a manner as that, after having passed the perpendicular at DE, it shall incline more and more to that side, until, at its termination at the point G, it has formed an angle with the surface of 45°. In this manner, the surface of the wedge will represent the right-hand side of the mould-board and share, beginning at a point, rising by a gradual slope from the horizontal plane to the vertical position, and then gradually inclining towards the right-hand side, until it forms with that side the angle required to press the sod into its position. It is to be observed that, when the furrow-slice has reached its perpendicular position at D, it begins to be turned upon a new pivot, so that there is a slight change in the curvature of the wedge at that point; and further, it is to be observed, that when it has reached this perpendicular position, it must be no farther acted upon by the mould-board below, for which reason all the hinder and lower part of the wedge DGH must be cut away in the manner shown in the different figures of the mould-boards.

The surface of the share and mould-board has been described as uniform; but in practice it is not to be made entirely uniform, on account of the resistance of the earth being greater at certain parts of the ascent of the furrow-slice than at others. Thus, towards the point of the share, the resistance to be overcome is greater than at the extremity of the mould-board, and therefore the wedge is made more acute at that part than behind.

A curved surface, such as has been described, may be formed by various means. These, however, need not be here described; neither is it necessary to explain in detail the several corrections to be made on the form of the parts. The nature of the curved surface will now be understood; or should any obscurity exist in the description given, it will be removed on examining the implement itself. The reader will perceive that the surface of the wedge described is resolvable into two planes, one of which acts in elevating the sod, and the other in moving it to a side, and that the general effect is to raise the sod, press it to a side, and turn it over.

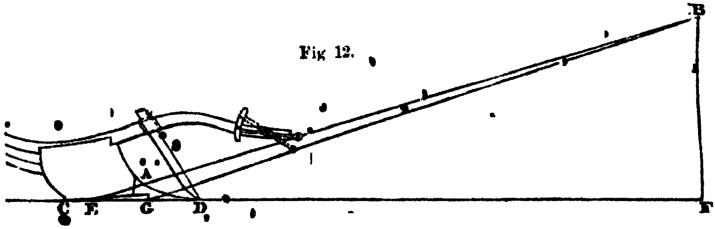
The perpendicular height of the mould-board may be 15 or 16 inches, being that height which is sufficient to prevent the loose earth from being thrown over it when the plough is at work. The width of the plough below, measured from the left-hand side to the point of the mould-board F, Fig. 7, where it is begun to be cut away, and where its surface is perpendicular, should be just equal to the width of the sod, and which, it has been stated, may be assumed to be 10 inches. The lower part of the plough from the point of the share C to the heel E, Fig. 9, should be of that length which is sufficient to give steadiness to the motion of the instrument, and need in no case exceed 66 inches. It is the error in rude ploughs that these parts are formed unnecessarily large, and especially the width below, by which means the resistance is uselessly increased.

An essential property of the plough is, that it shall move in the earth with a steady motion, and the giving to it the form and combination of parts necessary for that purpose is one of the main difficulties attending its construction.

Were it ascertained by experiment on the plough when at work, at a given depth of furrow, and in soil of a given texture, that a cord attached to any point A, Fig. 12, and drawn in the oblique direction AB, would so pull forward the plough, that it should press uniformly upon the earth at all points, from C to D, so that the share should neither tend to point upwards nor downwards, but should move horizontally forward, then it is to some part of this line that the moving power should be applied; and further, it is known from the principles of mechanics, that it matters not, in so far as regards the force exerted, to what precise part of this line the power is applied. Now, without entering into any mathematical investigation of the principles upon which this line is to be determined, it is to be observed, that, in a well-made plough, formed on the principles pointed out, this line, drawn from the usual point of attachment of the draught on the collars of the working cattle, will intersect the sole of the plough at E, a little behind the setting on of the share, and a little to the right of the plane of the left side of the instrument.

Now, knowing the height at which the point of draught is to be attached to the shoulders of the working cattle, let us suppose 4 feet, and the distance from the point of the share at which the animals of draught can be conveniently yoked, let us suppose 12 feet, then laying off DF 12 feet, and FB 4 feet, and drawing BE; it follows that the point at the end of the

Fig 12.



beam, to which the draught is attached, may be placed in any part of the line BE. So that whatever be the length which we shall give to the beam, the line in question will denote the end of it, or the point to which the draught is to be attached.

But the angle which the line EB forms with the surface, is not, as can be shown, constant, but varies with the depth ploughed, and the tenacity of the soil. That the instrument may suit itself to these variations, as well as that any defects in the form of its parts may be counteracted, and that the line of draught may be placed in that position which is required to pull forward the plough, without there being any tendency in the share to sink into the ground or rise out of it, the bridle is fixed at the end of the beam, so as to elevate or depress the line of draught, as may be required. Should the plough, for example, tend to go deeper into the earth, the line of draught is to be lowered by means of the bridle, so that it shall form a greater angle BGF; the effect of which will be to counteract the tendency which the plough has to go deeper. The same effect will be produced by shortening the traces by which the horses are attached to the draught, and thus increasing the angle. In like manner, by means of the bridle, the point of draught can be shifted to the right or to the left. If the point of the share tends to turn to the left hand into the firm ground, the line of draught is shifted more to the left, and if to the right hand, it is shifted more to the right. This adjusting of the plough's motion is easy, and is performed by the ploughman, until he feels that the plough continues to *swim fair*, to use his own technical language; that is, until he feels, which he does at once, that it continues to move horizontally forward, without any tendency to turn to the right or left, or to rise from the earth or to sink into it. A well-constructed plough of this kind, therefore, needs no wheels or other devices to steady its motion; the effect being produced by merely altering the direction of the line of draught.

The undoubted honour of having perfected this species of plough belongs to James Small, an ingenious mechanic of

Scotland, who, by observing the defects of the ancient ploughs, succeeded in forming an instrument which may be used in every part of the world, and which has added millions to the wealth of his native country. A treatise by him remains to show the steps by which he arrived at the discovery of the principles on which a plough should be constructed. His machine is alike efficient and simple. In the countries where it is used it is drawn by two horses yoked abreast, and is capable of performing, by easy labour to the animals of draught, almost every species of tillage which the plough is required to perform.*

Although the animal of draught employed in this species of plough is the horse, as being better suited than the ox to the variety of labours in which the husbandman of this country employs his working-cattle, and to the dispatch which he deems essential in all his operations, yet it does not follow that the horse is to be preferred to the ox in all countries and in all cases. In many countries the ox may still, on account of his more easy means of support and other qualities, be advantageously used. But whether the ox or the horse be employed it matters not, in so far as it regards the construction of the simple and efficient machine which has been described. It is equally suited to either species of draught, and only requires that the height of the beam shall be varied a little to suit the animals employed, and the manner in which they are attached to the yoke. When horses are used, they are attached by an apparatus of swing-trees, as in Fig. 13, to the bridle at the beam by a hook at A. These swing-trees being connected together, each horse pulls against the collar of his fellow, so that each must exert an equal force in pulling. They are attached by chains or traces, CC, to their respective swing-trees.

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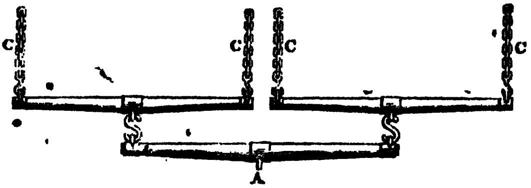
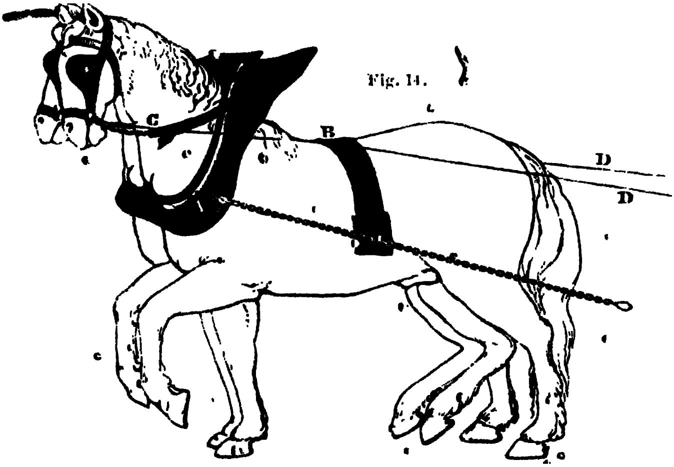
* A description of the plough of SMALL, with an explanation of the principle of its construction, was communicated by me to the Counseil Royal d'Agriculture de France, and, with accounts of the harrow, grubber, and other implements, was afterwards published in the Quarterly Journal of Agriculture.

Fig. 13.



The chains or traces by which the horses are yoked, are fixed to hooks on the collar as at A, Fig. 14. The traces are prevented from falling down by a broad belt of leather B, fastened to the traces, and passing over the back of each horse. Each horse has a snaffle-bridle C, and a cord is attached to the inner ring of each bridle, and to the trace of the opposite horse, for the purpose of keeping the horses together. A long rein is attached to the outer ring of each bridle. DD, and looped to each handle of the plough. With these, assisted by the voice, the ploughman directs the horses, and uses the reins instead of a whip, when necessary, to urge the animals forward.

Fig. 14.



Resting between the handles of the plough is a little spade with a long handle, with which the ploughman removes the mud that may be collected on the mould-board, or any substance that may be collected between the beam and the coulter, or between the beam and the forepart of the mould-board.

Fig. 15.

Wheels, in many ploughs, are attached to the point of the beam. It is believed that it could be shown that the labour of draught is not lessened by this device. The plough with wheels is, however, more easily managed, and thus may be guided by a less skilful workman.

The manner of ploughing a given piece of ground, as a field or a ridge, will be described under the head Simple Operations of Tillage.

2. *The Harrow.*

This instrument succeeds to the plough in the order of description, and the uses to which it is applicable. It consists of a frame of wood or iron, in which a certain number of teeth are fixed, which are pressed into the ground by their own weight and that of the frame. The instrument is intended to pulverize the ground which has been acted upon by the plough, to disengage from it the roots and other substances which it may contain, and to cover the seeds of corn and other cultivated plants.

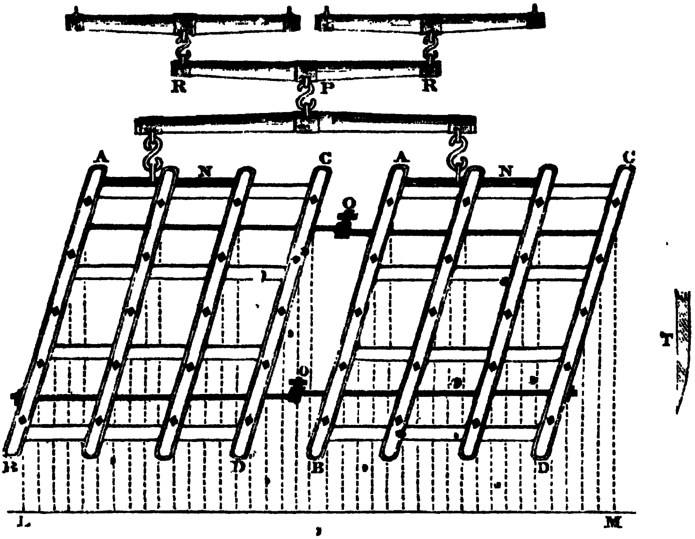
The harrow is greatly more simple in its form than the plough. It is even an imperfect machine in any form of which we can construct it; yet it is of great utility in tillage, and should receive all those mechanical improvements of which its nature will admit.

The harrow performing its operation by means of a certain number of teeth moved forward in the ground, and pressed downwards by their own weight and that of the frame in which they are fixed, the first questions that occur in investigating the principles of its construction are, the form that should be given to those teeth, and the manner in which they should be disposed in the surmounting frame. Were it the purpose, in harrowing, solely to drag up the roots of plants and other substances from the ground, the best form, perhaps, that could be given to the teeth would be that of a thin wedge, tapering to the point, like the coulter of a plough, and, like it, inclining forward. But although this construction might be the best calculated for tearing up roots and other substances beneath the surface, it would not be so well fitted for covering seeds and for breaking and pulverizing the ground, as when a broader surface was presented to the earth, and a greater movement given to its particles. The wedge for this purpose should be broad rather than thin. In order, therefore, to adapt the form of the teeth to this purpose,—to the strength necessary to be given to them, and to the lateral or shaking motion to which they are subjected in passing over rough ground, as well as to their forward motion,—it is conceived that the best form of them will be when their horizontal section is a square, whose diagonal is moved forward in the line of the harrow's motion; while they should gradually taper to a point, the forepart being kept straight, as in T, Fig. 16.

With regard to the distribution of the teeth in the frame of the harrow, they should not be placed too closely together, for then they would be too much impeded by the obstacles opposed to them: Further, they should be so disposed with relation to one another, as that one part of the instrument shall not be more interrupted than another: Again, their number should not be too great, because then their power to penetrate into the ground will be diminished, unless the weight of the whole instrument shall be increased in a corresponding degree: And lastly, their length should not be greater than is necessary, because they will not on that account penetrate more deeply into the ground, unless the whole weight is also increased, and because this increase of length will give a greater power to the teeth, when encountered by obstacles, to split the frame in which they are fixed.

The harrows represented in Fig. 16, of which the frame is of wood and the teeth of iron, are formed with a regard to these general principles. They are connected together in pairs by hinges. They consist each of four bars of wood, AB, CD, &c., which are joined together by an equal number of cross bars of smaller dimensions, mortised through them. The larger bars may be 2½ inches in width or more, by 3 in depth, and the smaller 2¼ inches in width by 1 in depth. The larger bars are placed oblique to the smaller bars, and to the line of the harrow's motion, and the teeth are inserted into them at equal distances from one another. This inclination is made to be such, that perpendiculars from each of the teeth falling upon a line LM, drawn at right angles to the harrow's motion, shall divide the space between each bar into equal parts, so that the various teeth, when the instrument is moved forward, shall indent at equal distances the surface of the ground over which they pass.

Fig. 16.



The number of teeth in each harrow is 20, 5 being inserted in each of the larger bars. When two harrows, therefore, are employed together, the surface of the ground from L to M is indented by 40 teeth, impressing the ground at equal distances from one another, and covering the space of about 9 feet. The teeth may project below the under surface of the frame 7 or 8 inches, their length somewhat increasing from the hindmost to the foremost rows, where the oblique position of the line of draught tends most to elevate the harrow. The teeth are often inserted into the frame with a little inclination forward; but this deviation from the perpendicular, if made at all, should be very slight, because it renders the harrow more apt to be impeded by the weeds or other substances collected in the angle between them and the frame. The teeth are fixed in the bars by boring holes with an auger of about ¾ of an inch in diameter, and then driving them firmly through. The teeth, when thus driven into the bars, will be retained with sufficient firmness. The best of the common kinds of wood for the larger bars, as being the least liable to split, is elm, birch, or ash, and for the cross bars, ash.

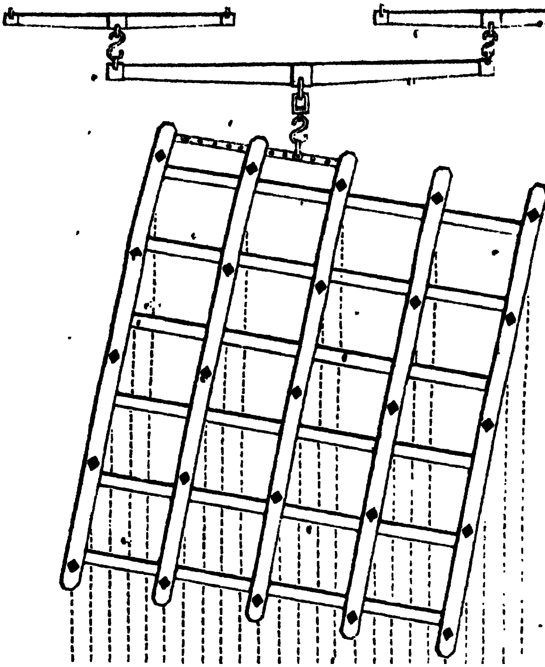
The iron rods which terminate in the hinges O, O, may pass through the framework to give it greater strength. These rods keep the harrows at the distance required, and the hinges admit of either harrow rising or falling, according to the inequalities of the surface. When thus joined, the harrows are drawn by two horses guided by reins, the driver walking behind so as to be prepared to lift up either harrow when choked by weeds, or otherwise interrupted.

The method of attaching the animals of draught will be explained by the apparatus of swing-trees shown in the figure, by means of which each animal must exert an equal force in pulling. There are plates of iron N, N, passing through the left-hand bars of each harrow. These plates have a few holes in them, so that the line of draught may be shifted to the right or left as may be required. The staple P upon the swing-tree R R being the point to which the moving power of the harrow is attached, it is important to ascertain its proper position.

Were a perpendicular to be let fall from the staple P upon the line L M, the point of intersection would be in the middle of the entire breadth covered by the harrows, and an equal number of teeth would be on each side of the line of traction, and this would seem to indicate the position of the staple P. But the larger bars being placed oblique to the line of the harrow's motion, when any obstacle raised above the surface of the ground strikes one of these bars, it tends to press it to the right-hand side. And as there are 8 bars of this kind, and these of considerable length, it will appear that, in ground where there is any great unevenness of surface, there will be a constant succession of strokes, forming a strong lateral pressure on the left side of the several bars. But the staple P being nearly fixed in its position, while the harrows may be moved round, the effect of this lateral pressure is to turn the whole harrows on P as a pivot from left to right. In practice, accordingly, there is found to be a constant tendency in the harrows of this construction to swing around from left to right, and this often to so great a degree in very rough ground, as to place the larger bars parallel to the line of motion, thus causing all the teeth in the same bar to follow in the same track. Hence the point P ought not to be precisely in the middle of the space covered by the harrows, but placed somewhat to the left hand, in order that so great a number of teeth may be placed on the right side of the line of traction as to counteract the tendency of the harrows to turn from left to right. But further, the position of P is not fixed, but must vary with the roughness of the surface over which the harrows are dragged. Hence not only must the staple P be placed somewhat to the left hand, but there must be the power of moving it more or less towards the left hand, according to the roughness of the surface passed over. This is effected by the iron plates, with holes, of which mention has been made, and by means of which the driver can readily shift the line of draught more or less to the left hand, as may be required.

A species of harrow was formerly much in use, and is still frequently employed, of much greater weight and dimensions than the ordinary kinds, each single harrow being drawn by two horses. These larger harrows were termed Breaks. They were intended to till the stronger clays, at a time when they were too hard to be impressed by the teeth of the common harrow. There were differences in the form of these instruments. One method of their construction is represented in Fig. 17, in which there are five large bars, and twenty-five teeth, and where the line of draught is so attached as that the teeth shall impress the ground at equal distances.

Fig. 17.

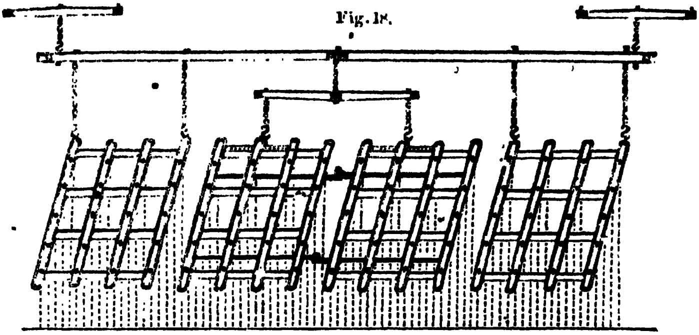


The heavy harrows of this kind, however, cannot be said to be indispensable, even on the most stubborn clays, since, at those times when the lighter harrows are unable to operate, other instruments may be employed.

Sometimes a light kind of harrow, with a greater number of teeth, is used for covering the smaller seeds, as those of clovers and the grasses. These light harrows do this species of work better than the common kinds, and hence many farmers have one or more pairs of them for the specific purpose of covering the smaller seeds.

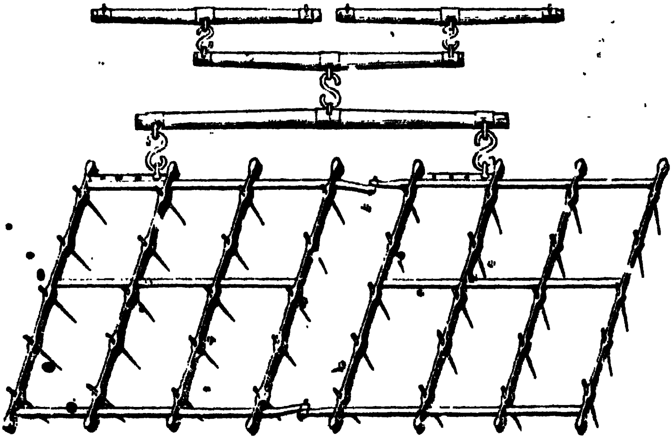
To prevent injury to the surface, when it is necessary to sow land in a very wet state, several harrows may be attached together, and the horses made to walk in the open furrows of the ridges, to be afterwards described. These harrows may be attached to an axle, mounted on wheels, stretching the breadth of the ridge. But the same purpose may be more simply effected by merely attaching the harrows to a beam of wood of a length sufficient to stretch across the ridge, in which case the two middle harrows may be connected together by hinges, in the usual manner, while, to keep the outer ones at the distance required, each of them may be attached to the cross beam, in the manner shown in the figure.

Fig. 18.



The harrow has been here described as formed of wood, with teeth of iron. The whole, however, may be formed of malleable iron. The advantages of the iron harrow are, that it is more durable, and that a smaller surface being exposed to the resistance of obstacles on the ground, it is not so much resisted as when the frame-work is of wood. On this account it does somewhat more work in proportion to its weight. The following figure represents the harrow as formed of iron.

Fig. 19.



In these figures, the harrows are shown as closely connected by their hinges: but they may be also more loosely connected, so that each harrow shall have a little separate play, and this is conceived to be an improvement in the construction.

THE GRUBBER.

The uses of the harrow, it has been seen, are to pulverize the ground which has been subjected to the action of the plough, to disengage from it the roots of plants and other substances which it may contain, and to cover the seeds which are sown upon the surface.

The harrow, however, performs imperfectly a part of these operations. It is not well suited to penetrate into the ground, and drag up the roots of plants beneath the surface. The teeth being forced down solely by their own weight and that of the frame in which they are fixed, which is not considerable, they are ill fitted to make an impression upon the ground, and they are easily thrown out of it by the obstacles which they encounter. In soil which is in any degree tenacious, therefore, the impression made by the teeth of the harrow is often seen to be very slight. Were the teeth, as was before observed, formed like the coulter of a plough, and set in the same position, they would better insinuate themselves into the ground, and be somewhat less liable to be forced out of it. But the harrow, from its nature, could only admit of this construction in a very limited degree; for were the teeth to form a sharp angle with the frame-work in which they were set, the roots and other substances disengaged from the ground would be collected at the angles, and would thus be carried along with the harrow and impede its progress; while the difficulty would be increased of freeing the teeth from the substances collected.

To obviate these defects of the harrow, instruments have been employed, which, from their weight and construction, are better able to penetrate into the soil, and maintain their position at the depth required. They are termed Grubbers, Cultivators, Extirpators, &c. They are of greatly more recent introduction into agriculture than the plough and the harrow.

One of this class of instruments, termed Finlaison's Harrow, from the name of its inventor Mr John Finlaison, has been found to be an efficient machine. It is made wholly of iron. It consists of two parallel sides A A, with two sets, or pairs, of cross-bars, as shown in the figure. Into the hindmost of these sets are inserted five curved teeth or prongs, and into the foremost four prongs. A little before the foremost prongs, the sides begin to converge so as to meet at B, where they are attached by a bolt to the long handle C, fixed to which, by a connecting bar, is the wheel D, which runs upon the surface. Behind is a species of spring E, consisting of two elastic rods with openings, and supported in the manner shown in the figure. The handle, which is retained in its place in the openings of the spring, may be forced up and down by pressing it; and as the handle and the fore wheel are joined together, by raising the handle, the fore wheel will be raised also, and the prongs allowed to go deeper into the ground. When the handle is at the lowest opening in the spring, the foremost prongs are lifted out of the ground; and in proportion as the handle is pressed up into each successive opening, the prongs descend, until the handle is at the topmost opening, when they will be between eight and nine inches in the ground, which is the greatest depth at which it is necessary to set them. The axles of the two hindmost wheels, may, by means of an apparatus attached to the side bar, be elevated or depressed, and thus the hinder prongs made to correspond in the depth at which they are set with the foremost.

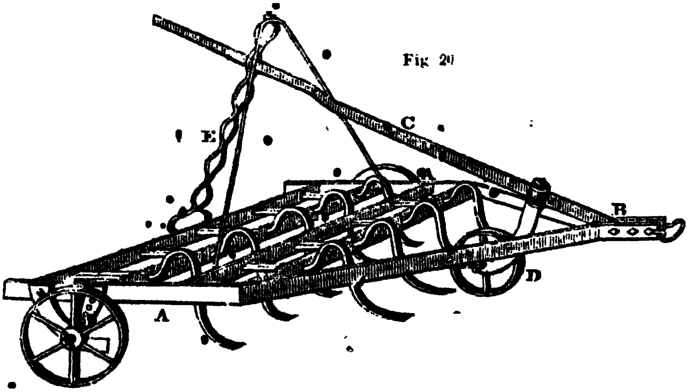


Fig. 20

The entire space covered by the prongs of this machine is 5 feet 4 inches. The length of each prong is 29 inches; and the weight of the whole instrument is about 486 lb. On stiff clays, or on soils not loosened by previous ploughing, four horses are required to work the machine; and in ordinary cases, with tolerably light land, three horses. There is also a smaller and lighter form of the instrument with seven prongs, which covers a space of four feet. This, on heavy land, requires three horses, and on light land two horses to work it

An improvement may be made on this instrument, by means of which the prongs can be lifted perpendicularly from the ground, somewhat in the manner shown in the next figure.

Another instrument of this class is Kirkwood's Grubber. This is formed wholly of iron, and consists of a frame-work as shown in Figs. 21 and 22, in which are fixed seven prongs or coulters, so placed as to move at equal distances from one another.

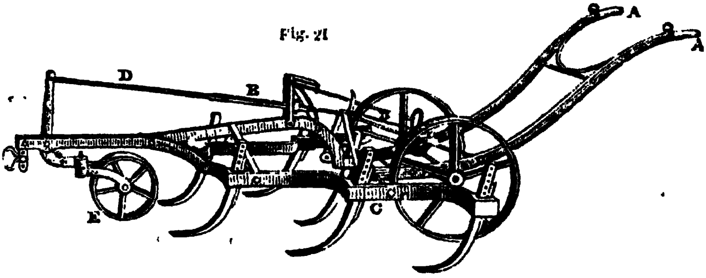
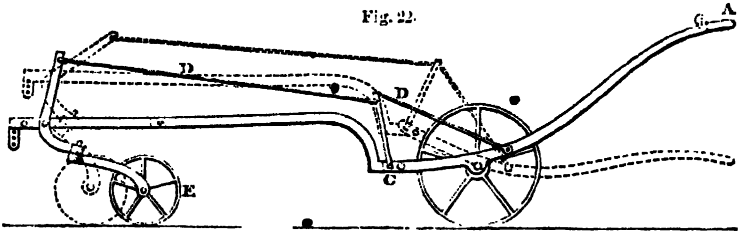


Fig. 21

The frame-work, it will be seen, rests upon three wheels. The handles AA move upon the axle of the two hindmost wheels, and they are extended forward to a cross-bar at C, which forms part of the frame in which the coulters are fixed. The handles when moved act as levers, of which the fulcrum is the axle of the two hindmost wheels. By depressing the handles, they raise the cross-bar at C, with which they are connected, and consequently the hinder part of the frame in which the coulters are fixed. Further, the handles are connected by means of rods DD with the fore-wheel E. The same depression of the handles, therefore, which elevates the hinder part of the frame-work, draws back the connecting-rods, and, acting upon the fore-wheel E, depresses it, which is equivalent to raising the fore part of the frame-work. A depression of the handles, therefore, raises, at the same time, the hind part of the frame-work by acting upon the bar at C, and the fore part of the frame-work by acting upon the wheel E. Thus, an elevation or depression of the handles elevates or depresses the whole frame-work, and consequently causes the coulters to move at a greater or less depth in the ground. By means of a simple contrivance at B, the connecting-rod D is fixed in its position, and thus the whole frame is kept at the elevation required. The action of the handles and connecting-rods will be further seen in Fig. 22, which represents a section of the machine, the dotted lines showing the change of position produced by the depression of the handles.

Fig. 22.



By depressing the handles sufficiently, the whole coulters may be lifted out of the ground when the machine is turned at the end of ridges, when it is moved from one field to another, or when it encounters great obstacles in the ground, as stones. The various coulters being fixed in their places by keys or wedges, they may be removed, or set at a greater or less depth, according to the depth at which the ground is to be tilled.

The space covered by the coulters is 4 feet 4 inches; the coulters are 14½ inches long below the bars, 2 inches broad, and about ¾ of an inch thick. The diameter of the hindmost wheels is 22 inches; and the weight of the whole machine is about 4 cwt.

The introduction of this class of instruments into tillage must be regarded as beneficial and important. When land is full of root-weeds, the repeated operation of the plough, the harrow, and the roller, is resorted to for tilling and cleaning it. In these cases the grubber is a useful assistant, and may frequently supersede the necessity of one or more ploughings. Under certain other circumstances it may also beneficially supersede the plough. Thus, in very warm weather, certain stiff soils are frequently rendered hard and compressed by being turned over by the plough and exposed to the parching influence of the sun. In such cases, the stirring of the soil may often be performed by the grubber alone, without the necessity of turning over the soil.

The grubber can be made to go to any depth which may be required, and thus the soil can either be stirred to the depth at which it had been originally ploughed, or to such lesser depth as may be deemed expedient. It is, in this respect, greatly superior to the harrow, which we cannot regulate in this manner. The employment of the grubber, however, does not supersede that of the harrow in the pulverization of the ground and disengaging of the roots of weeds. The harrow is still to be used in conjunction with the grubber, and especially for collecting into heaps the roots of the plants brought to the surface.

In the same class of instruments is one employed in some parts of England, termed a Drag. The drag is merely a strong triangular harrow, kept in the ground by handles assisted a little by the form of the teeth. It is usually drawn by four horses yoked abreast, and can go over about ten acres in the day. The land being ploughed, the drag passes across the field, and then the harrows follow to complete the operation and collect the weeds.

The Roller.

The Roller is an instrument intended either to smooth and consolidate the surface of the ground, or to pulverize the clods of earth turned up by the action of the plough and the harrow.

The roller chiefly employed is a solid cylinder of wood, or a hollow cylinder of cast-iron, surmounted by a strong framework of wood, in the shafts of which is yoked one of the animals of draught. The other animal, when two are employed, is attached by chains to the shafts, and moves in a line before. The manner in which the frame surmounts the cylinder, on the pivots of which it rests, will appear in the following figure.

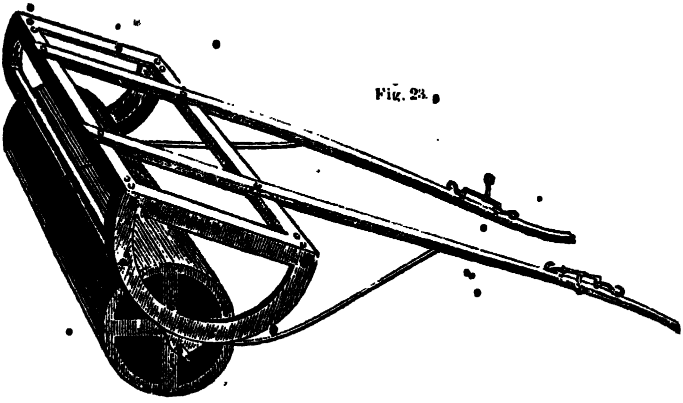


Fig. 23.

The length of the cylinder of the roller may be 5 feet and its diameter 24 inches. The substitution of cast-iron for wood is a great improvement in the construction of this machine, on account of the superior durability of the material, and because the iron surface is less apt than the wood to collect mud as it moves along.

Frequently, instead of one long roller, the cylinder is divided into two, as shown in the figure, so that each part may revolve separately. The design of this is to diminish the labour of the cattle in turning. Sometimes upon the frame is fixed a large box, in which are put stones to increase the weight. The weight of the roller, however, will be best increased by adding to that of the cylinder; for the adding to the weight of the frame increases the friction in the way in which it is most considerable in the machine, namely, by the pressure of the surmounting frame upon the pivots. For the same reason, it is an error to render the frame too heavy, the weight being always better increased by an addition to the weight of the cylinder, than to that of the frame.

For the constructing of this machine, it is important to know whether the cylinder of large or small diameter be the most efficacious.

Contrary to the opinion very generally entertained by the makers of the instrument, the roller with the larger, is superior to that with the smaller, cylinder. It is conceived that it can be fairly deduced from a consideration of the form and mode of action of the machine, that comparing together two rollers with cylinders of unequal diameter, that with the larger cylinder will be more efficacious than that with the smaller cylinder, because a greater weight can be brought by the exertion of the same force to act upon the ground.

The manner of using the roller, and the cases in which it is to be employed, will be afterwards explained.

The weight of the roller may vary with the nature of the soil upon which it is to act. On farms of stiff clays it may be from 16 to 20 cwt., and on the lighter class of soils a weight of 12 cwt. is sufficient.

The cast-iron roller is subject to be broken when dragged along a hard road, to obviate which may be employed a low frame on wheels, on which the roller is then to be put.

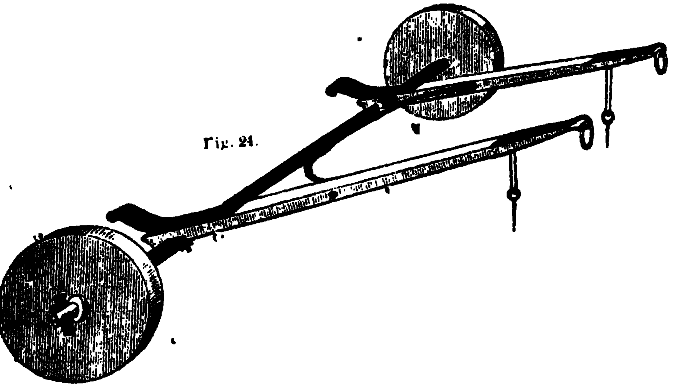


Fig. 24.

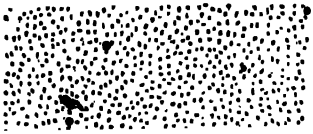
V. MACHINES FOR SOWING.

1. *Machines for Sowing Corn in Rows.*

The seeds of the different kinds of corn may be sown, either by being scattered irregularly upon the surface, or by being deposited in rows at given distances from one another. The first method may be done by the hand, the seeds being scattered from a basket, or from a sheet slung over the shoulder of the workman.

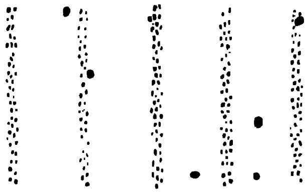
When seeds are scattered upon the surface, which is termed sowing broadcast, they fall upon it irregularly. They cannot be placed at equal distances from one another, but nevertheless, if the operation be performed well, the inequality of distance between individual seeds is too inconsiderable to affect the general result, and the average distance is sufficiently preserved thus:

Fig. 25



For the purpose, however, of allowing the ground to be tilled, and weeds to be destroyed during the growth of the plants, the seeds are frequently sown in rows, at given distances from one another, as 9, 10, or 12 inches.

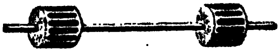
Fig 26.



In this case there is an interval between the rows of seeds, which, until the plants shall have spread their leaves and stems over it, may be tilled by hoes or other means. The sowing of seeds in this manner is termed the row or drill system, and different kinds of instruments are employed for sowing, according as the seeds may be those of cereal grasses, as wheat; of certain leguminous plants, as the bean; or of smaller seeds, as the turnip.

Various modes of construction have been adopted for this class of machines. Generally a frame-work is placed upon two wheels, and upon this is an oblong box for containing the seeds. From the axle of the wheels motion is communicated to a spindle or axle, which passes horizontally through the lower part of the box, and upon this axle may be fixed, at the distances required, a series of grooved or fluted cylinders.

Fig. 27



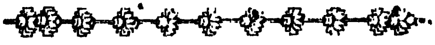
There are apertures formed near the bottom of the box, and as each cylinder revolves amongst the seeds, a certain portion of them is collected in the grooves at each revolution, and is carried round in the grooves, and falls through these apertures. By making the grooves larger or smaller, so as to contain a larger or smaller quantity of seeds, or by making the apertures of the seed-box larger or smaller, so as to allow a larger or smaller quantity of seeds to pass through, the machine can be made to sow the seeds more or less thick, as may be required.

The seeds, after passing through the apertures, fall into tubes or funnels, through which they are conveyed to the ground. Immediately before the lower part of each funnel is a sharp hollow coulter of iron, which encloses the lower part of the tube, and makes a rut in the ground into which the seeds fall. By these means they are sown in the quantity required, and at the depth to which we choose to set the coulters.

To allow the rows to be at larger or smaller intervals, the cylinders are generally moveable upon the spindle, so as that they may be set at any distance required, as 9, 10, 12, or more inches. The coulters are made to move at the depth required, and to be lifted up along with the tubes or funnels when necessary, as at the turning at the end of ridges, the encountering of obstacles, and the like.

Sometimes the axle, instead of having cylinders upon it with grooves, has a series of small pinions or teeth.

Fig. 28.



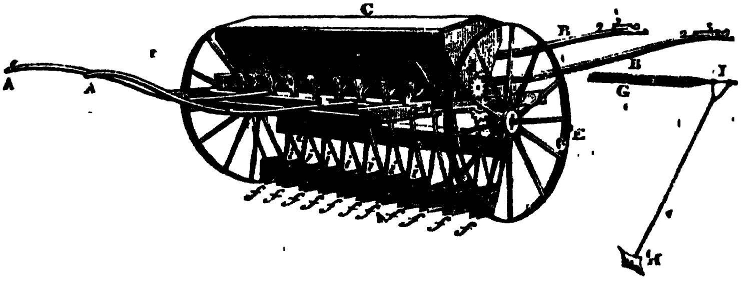
Or, in place of the teeth, there is employed a series of stiff brushes. The teeth or brushes revolve in the same manner as the fluted cylinders, and by keeping the seeds in motion, cause them to fall through the little apertures or holes near the bottom of the box. The holes are made to be enlarged or diminished by means of a sliding iron-plate, placed upon them, with an equal number of similar holes with those of the iron-plate. When the holes of the seed-box and the iron-plate correspond, that is, when they are placed exactly one upon the other, the holes through which the seeds drop are of their largest size. But by moving the iron-plate a little to a side, the holes do not entirely correspond, and hence the holes through which the seeds fall are lessened; and by moving the iron-plate still further to one side, so as that no part of the two sets of holes shall correspond, those of the seed-box are entirely covered. The iron-plate which thus lessens or closes the apertures of the seed-box, is moved by a lever, and fixed in its position by screws.

In Fig. 29, the principle of construction is that of teeth or brushes fixed upon an axle, which is more simple than when the method of grooved cylinders is adopted, and is found in practice to be equally or more efficient.

C represents the seed-box, formed with a lid at top, by which the seeds are introduced. At its lower part are the holes through which the seeds fall, and covering them all is a thin iron plate with corresponding apertures. By moving the iron plate, which is done by means of a lever, the holes of the seed-box are enlarged or diminished to the degree required; and *i i i i*, &c. are a series of tin tubes, enlarged at the upper part where they are in contact with the seed-box, which lead to the hollow iron coulters *f f f f*, &c. These hollow coulters are sharp before and open behind. They inclose the tin tubes at their lower end, and make a rut in the ground, into which the seeds fall. In the figure, 11 of these coulters with their corresponding tubes are shown; and they are so made as that by means of a simple contrivance, some of them may be closed up, and the others placed at equal distances from one another: In this way 7, 9, or 11 rows may be sown as may be required.

At the bottom of the seed-box within, is placed the horizontal spindle on which are fixed the teeth or brushes, which, agitating the seeds in the box, cause them to fall through the holes into the tubes. Motion is given to this spindle by means of a toothed wheel upon the axle of the wheel E. This moves a small intermediate wheel, and this again the wheel K placed upon the end of the spindle. In this manner the spindle with its brushes or wheels revolves amongst the seeds, and by the motion which it gives to them, causes them to fall through the holes into the tubes, whence they are conveyed to the ground. When the spindle is stopped scarce any seeds fall through the apertures, and by means of a lever L, the workman has the power of throwing the moving wheel out of geer, and thus stopping at once the revolution of the spindle. BB are the shafts attached by means of hinges to the machine, between which the animal of draught walks; and AA are the handles upon which the workman presses, and by elevating which, he is enabled to lift up the seed-box and coulters, so that the latter may, if required, be raised entirely out of the ground. G represents a part of a long wooden bar, with a rod and sharp piece of iron H, fixed to it by hinges at I. The purpose of this is, that when the machine moves across ridges, which is the way in which it is often employed, a mark or rut may be made in the ground: and when it returns the animal of draught walks in the rut or track which had thus been formed, and which is accordingly the guide or mark by which the workman is enabled to direct the course of the machine. This marker is made to be lifted to either side as may be required. The attachment of it to the machine is not shown, on account of the smallness of the figure.

Fig. 20.



2. *Machine for Sowing Corn and Grass-Seeds Broad-Cast.*

The sowing of corn from the hand is known to be attended with some uncertainty, being dependent, for the accuracy of the execution, upon the skill and attention of the sower. The regularity of the work is also affected by winds. In either case, the means rarely exist of detecting the degree of imperfection, until the plants are above ground, when it is too late to correct it. As a remedy for these inconveniences, a machine has been introduced into agriculture, for sowing the seeds of corn and grasses broad-cast. The great recommendation of this machine is, the regularity and certainty with which it performs the work, the saving of seeds, and the rendering the execution independent of unskilfulness and the want of care in the operator.

The machine consists of an oblong box 16 feet or more in length, supported upon a frame-work with three wheels. Working at the bottom of the inside of this box, is a horizontal spindle AB, Fig. 30, upon which is fixed a series of pinions (or a spindle OP, on which is fixed a series of hard brushes), at the distance from one another of about 7 inches. Motion is given to this spindle from one of the hinder wheels, by means of the axle C, upon the end of which is fixed the mitred wheel D. This works into a small mitred wheel upon the little shaft E; which again, by means of another mitred wheel working into a similar wheel F, gives motion to the horizontal spindle. In this manner the spindle with its pinions or brushes, is made to revolve as the machine moves forward. At the lower part of the seed-box within, are hollowed out cavities, in which the several pinions work; and at the bottom of each of these cavities is a small aperture or hole, through which the seeds fall. There is thus along the whole bottom of the seed-box, a line of holes; and a long thin iron-plate upon the outside of the seed-box is made with similar holes. This iron-plate is moveable by means of levers, and is made to be fixed in a given position by screws. When the holes of the iron-plate are placed so as to correspond exactly with

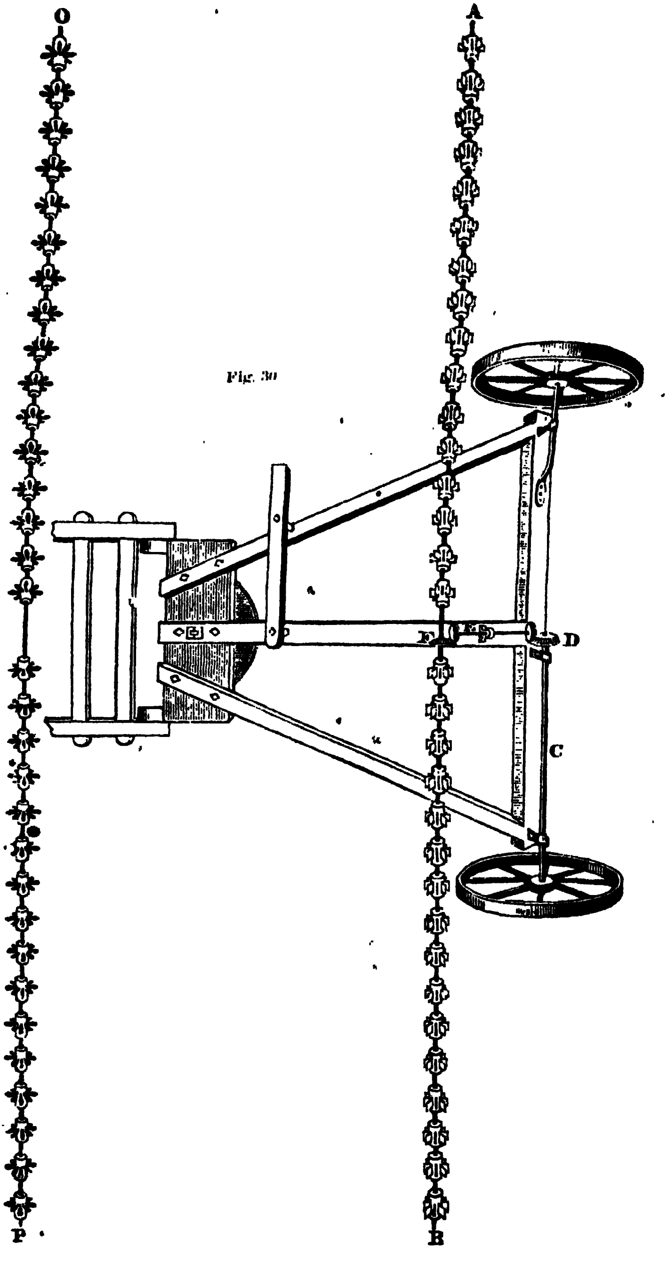


Fig. 30

those of the seed-box, the holes through which the seeds fall are of their largest size. By pressing the iron-plate a little to one side, it partially covers the holes of the seed-box, and thus the holes through which the seeds fall are diminished; by pressing the iron-plate still more to a side, the holes of the seed-box are covered, and no more seeds fall through. In this manner, precisely as in the case of the drill-sowing machine, the apertures of the seed-box can be enlarged or diminished, so as to allow a larger or smaller quantity of seeds to fall through. The seeds, however, in place of falling into tubes, and being thus conveyed to the ground, and deposited in rows, fall at once upon the ground, and so are sown broad-cast. They are then covered by the harrow, in the manner to be afterwards described.

Fig. 31 is a perspective view of the machine. AB represents the long wooden seed-box. CD are the shafts for the attachment of the animal of draught. LL are two small levers for the purpose of moving the iron-plate, and N is one of the screws for fixing it in its position. M is a lever acting vertically for the purpose of changing the position of the seed-box, which is sometimes required in the case of a steep ascent.

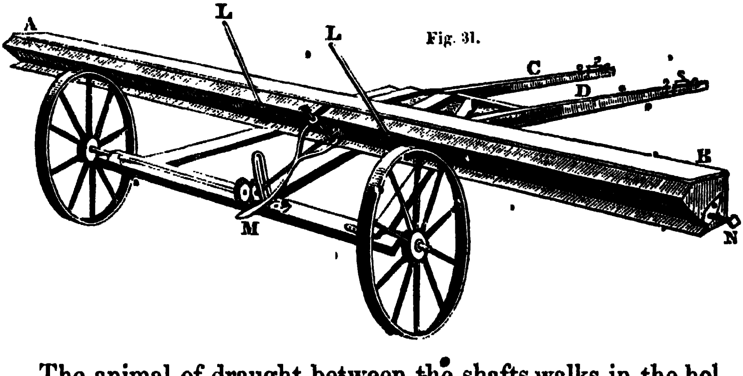


Fig. 31.

The animal of draught between the shafts walks in the hollow of the ridge, in which also moves the fore-wheel, which, however, is not seen in the figure, being hidden by the seed-box and frame. The long wooden box extends over half the space of each adjoining ridge, and thus the breadth of an entire ridge is sown at once. In order that the machine may be adapted to variations in the breadth of ridges, some of the holes at each end are made to be closed by means of sliders. The workman walks behind. A man and a horse with this machine, with the assistant required to bring forward the seeds and empty them into the seed-box, will sow from 20 to 25 acres in a day.

The regular manner in which the seeds are sown by means of this kind of machine, renders less seeds necessary than when the common method of sowing by the hand is practised. And, further, this greater regularity in the distance of the seeds from one another, produces a more equal growth or braird of the plants.

Besides the sowing of the cereal grains, the machine is well adapted to the sowing of the seeds of the grasses and clovers. The seeds of these plants are very minute, and more difficulty exists in sowing them with regularity than the larger grains, and in an especial manner during winds, when, from the lightness of the seeds they are easily blown away. When the seeds of clovers and grasses are to be sown, the spindle with brushes, in place of that with pinions, is to be employed.

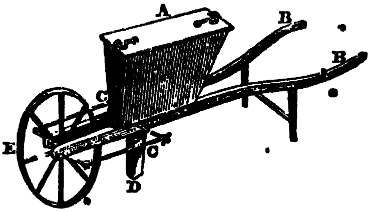
3. *Machines for Sowing the Seeds of the Bean and Pea.*

The seeds of the Bean being of larger size than those of the cereal grasses, a peculiar kind of machine is employed for sowing them.

The simplest of these machines consists of a seed-box, in the bottom of which works a grooved cylinder. At each revolution of the cylinder a quantity of seeds dependent upon the size of the grooves, is carried round, and these falling into a tube at the bottom, are conveyed to the ground. This machine is generally made to sow only one row at a time. It is thus so light as to be pushed forward by the hand, and is moved upon a single wheel like a wheel-barrow. From this wheel, motion is conveyed to the cylinder by means of cranks.

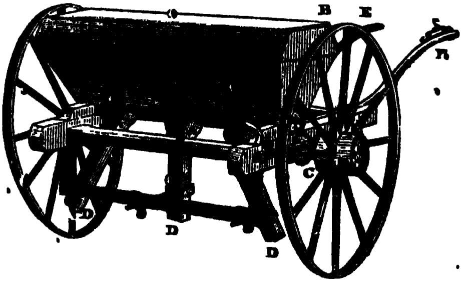
In the following figure, A is the seed-box, at the bottom of which the grooved cylinder works; BB are the handles held elevated by the workman; E is the wheel on which the machine moves: CC are the cranks connected with this wheel, which gives motion to the grooved cylinder within the box; D is the tube through which the seeds fall into the rut prepared for them in the ground, in the manner to be described, when treating of the culture of the bean.

Fig. 32.



But a better machine is now employed for sowing the seeds of the bean as well as of the pea. In this implement, as in the other, a grooved cylinder works in the bottom of a seed-box; but the seeds are conveyed to the ground by three tubes in place of one, so that three rows are sown at once. The machine is drawn by a single horse, and the seeds are deposited in the hollows between drills previously formed, in the manner to be explained when describing the culture of the bean and pea. Fig. 33 represents this machine: AB is the seed-box, and C the wheels by which motion is conveyed to the grooved cylinder; DDD are the tubes through which the seeds fall, and EF the shafts to which the animal of draught is attached.

Fig. 33.



4. *Machine for Sowing the Smaller Seeds in Rows.*

The seeds of the turnip and a few other plants cultivated in rows require a peculiar class of machines.

These differ very much in the details of their construction, and are more or less perfect in different parts of the country. Sometimes the method before explained of grooved cylinders is adopted, the size and mode of action of these being suited to the minute seeds to be sown. The seeds are then carried to the ground in tubes, defended at their lower part by coulters which make ruts in the ground into which the seeds fall.

In place, however, of using grooved cylinders, the more common method is to place the seeds in cylindrical boxes of iron or tin, which are made to revolve, and which being perforated in a line all round, the seeds fall through as the boxes revolve. Embracing the cylindrical box is a thin iron or tin plate, in which also are perforated sets of holes, by slight change in the position of which, a greater or smaller number of holes in the boxes can be covered, and so a greater or smaller quantity of seeds allowed to fall through.

Fig. 34, represents this method of construction. AA are two boxes or hollow cylinders of tin, with a row of holes round each cylinder. Into these cylinders the seeds are introduced by means of apertures with sliding lids. Motion is given to them by a pinion upon the axle of the wheel at B. This acting upon the intermediate pinion C gives motion to the pinion upon the end of the axle D. The cylinders AA being fixed upon this axle, they revolve in proportion as the machine is moved forward. The seeds falling into the tubes GG are conveyed to the ground. The hollow coulters HH defend the lower extremity of the tubes, and make ruts, into which the seeds fall. I is a lever, which, by means of a toothed wheel working into the teeth of the iron-plates KK, can move the lower ends of the coulters and tubes to a greater or smaller distance from each other, according as the rows may be somewhat more or less distant.

Fig. 34.

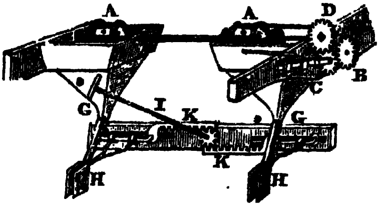
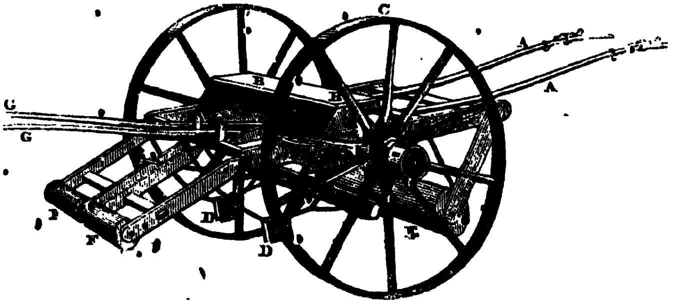


Fig. 35, represents the machine complete. AA are the shafts, to which is yoked the animal of draught. BB is a wooden box, in which are contained the cylinders, to which motion is conveyed by the pinion fixed upon the axle of the large wheel C. DD are the hollow iron coulters, in which the tubes for conducting the seeds to the ground terminate. FF are two light wooden rollers, which follow each track of the coulters, [illegible] is a larger wooden roller in front, the

and that the effect of this roller is to flatten and compress these drills just before the seeds are sown. GG are two handles which are held by the workman. These are attached to the coulters in such a manner, that when either handle is lifted up, the corresponding coulter also is raised; and thus the workman has the power of lifting up either coulter, when impeded by roots or other obstacles.

Fig. 35.



Sometimes the machines of this class are made to sow only one row at a time; but it is an improvement that they be made to sow two rows at once, both on account of the saving of labour, and of the greater steadiness with which the larger machine moves forward. Sometimes motion is communicated to the horizontal spindle, not by means of two wheels, as shown in the figure, but by a communication with the roller which flattens the ridges. These and other variations, however, in the construction, it is not necessary here to detail, the purpose being to describe one good machine, and not the many differences of construction of which this class of instruments is susceptible.

III. IMPLEMENTS FOR HOEING

The machines of this class are those which are employed for the purpose of tilling the intervals of plants which are sown in rows.

The plants which are cultivated in this manner are, in certain cases, the cereal grasses; in other cases, the bean, the pea, and such leguminous plants as are cultivated for their seeds; but, above all, the turnip and other plants of the cabbage family, the potato, the carrot, the beet, and various plants cultivated chiefly for their roots, bulbs, or tubers.

The instrument most generally employed for tilling the intervals of the cereal grasses is a hoe used by the hand; although, where the system is practised to a great extent, it is found convenient to employ a series of hoes, moved by horse-labour. These are commonly flat triangular shares, of such a size as to occupy the interval of the rows, and so formed as to be set at a greater or less distance from one another as may be required; and they are attached to a frame fixed on wheels.

But, in the practice of the farm, the hoeing instruments that may be considered as really essential, are those used for tilling the intervals of leguminous plants, as the pea and bean, of the plants of the cabbage family, and of the various species of plants cultivated for their roots and tubers.

A hoeing instrument for the latter classes of plants is a common plough, formed upon the principle of the plough already described, but of smaller size, and drawn by one horse.

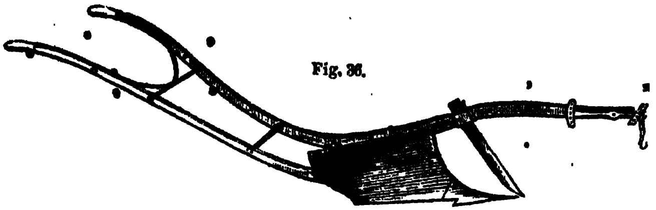


Fig. 36.

In using this plough, the animal of draught walks in the interval between the rows of plants. The plane of the left-hand side of the plough is made to go as near the line of plants as can be done without injury; and in this manner the plough cuts off a shallow slice of earth, and lays it in the interval between the rows. The same operation is then performed with *the adjoining row of plants by the plough returning in the* same inter[illegible]; [illegible] and thu[illegible] ing rows [illegible] tween them. This is a very efficacious species of tillage, though attended with some expense of labour. It is frequently used in the case of the first hoeing to be given to potatoes and turnips, in the manner to be afterwards described, and in the case of beans where the land is stiff and the intervals wide.

Besides this, however, are employed hoes of very various construction, which, by means of shares and coulters, or of coulters alone, till at one turn the entire interval between the rows of plants. These are sometimes made with beams in the manner of the plough, and sometimes without beams in the manner of the harrow. The former is, for general purposes,

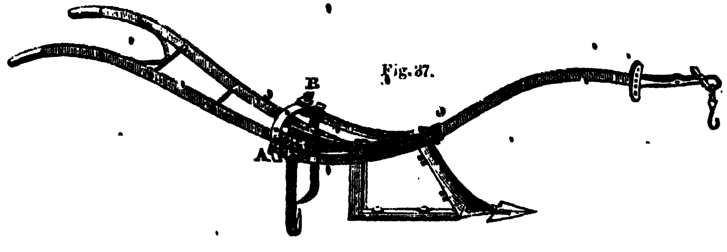


Fig. 37.

the best method of construction, and the figure represents a machine of this class suited to the different purposes to which it is applied.

It will be seen that it is formed with a beam and handles, like a plough. It has a triangular two-winged share, which passes between the rows of plants. Fixed to the horizontal bars are two upright coulters, bent inwards at the lower extremity. The bars to which these coulters are attached slide upon the cross-bar AB, and are fixed by hinges to the beam, and thus the upright coulters can be placed at such a distance from one another, as to work as near the rows as they can go without cutting or injuring the plants. In this manner, by means of the broad share in the centre, and the coulters at the sides, the entire space between the rows of plants is tilled.

Further, by removing the two lateral coulters, and substituting two mould-boards, a hoeing machine of this kind may be converted into another implement employed in tilling the ground—a double mould-board plough. The effect of using the lateral coulters in tilling, is to move, in part, the earth away from the plants. By substituting the double mould-board plough, the operation is reversed; for, by passing along the intervals of the rows, it lays back the earth towards the plants from which it had been moved by the action of the lateral coulters.

Fig. 37, represents the instrument, with its broad share and lateral coulters. Fig. 38, represents it when the coulters and bars to which they are attached are removed, and the two mould-boards are substituted.

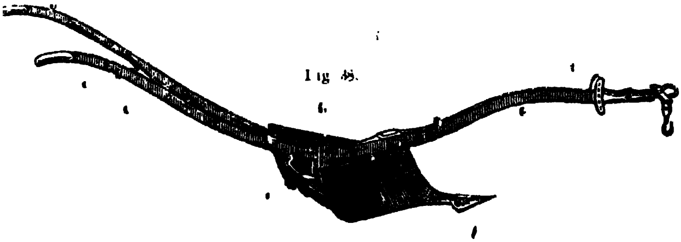
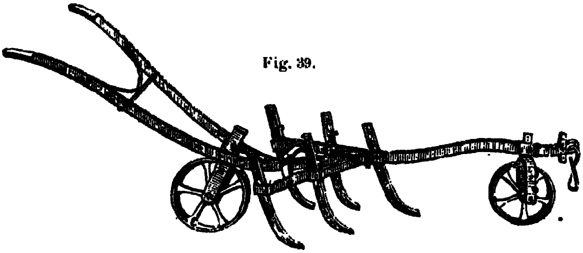


Fig. 38.

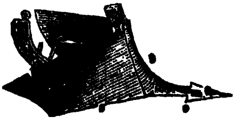
Although the machine described will, in most cases, answer the purposes required, yet, in the case of particular classes of soils, or rather in particular conditions of the soil, the broad share is found to raise up the ground in clods or masses, and to be sometimes inconvenient when the land is very full of weeds. In such cases, an instrument with coulters alone may be beneficially employed. The following figure represents a machine of this construction.

Fig. 39.



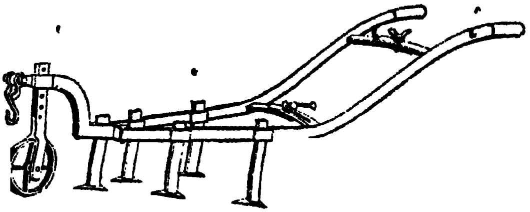
It is formed, like the last, of iron. In the centre is a coulter: and, attached to the beam, by hinges, are two bars, into each of which are inserted two coulters. The bars can be set at a greater angle to the beam, and consequently the coulters made to extend over a greater space and till a wider interval. Near the fore-end of the beam is a wheel, the purpose of which is to steady the motion of the machine; and there is sometimes behind another wheel, which adds to the effect, but which is not indispensable.

By removing the wheels, bars, and coulters, and attaching the apparatus shown in Fig. 40, the machine is converted into a double mould-board plough.



The following figure represents a simpler hoe of this class, which is as efficient as any that can be used. It is best constructed of iron. The lateral beams containing the coulters are moveable, and thus can be adapted to till a wider or narrower interval.

Fig. 41.



IV. MACHINES FOR THRASHING AND WINNOWING.

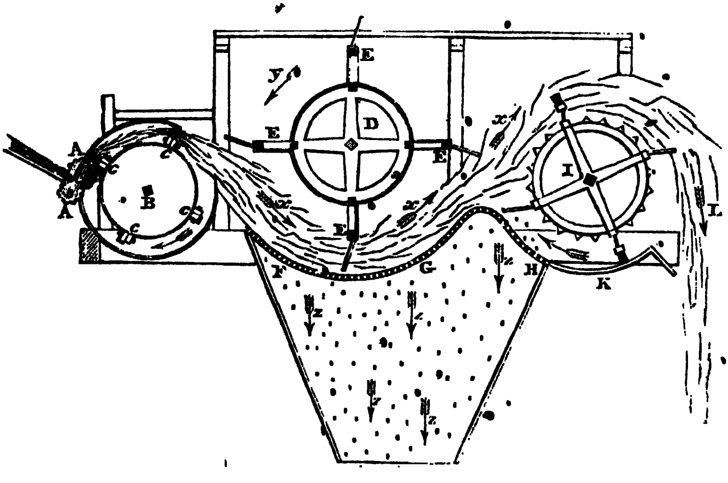
1. *Thrashing Machine.*

The separation of the grain of corn from the straw, has been effected by various means. That which is the most familiar, and which has been derived from the earliest times, is by the flail, a simple instrument, which consists of two staves bound together by tough thongs. One of these staves is held in the hands of the workman, and with the other the unthrashed corn is beaten with force. By this mean, the grain and husks are separated from the straw, and those again, by the further action of winnowing, from each other.

The flail, although efficient in the hands of an expert workman, is but a rude instrument. The operation performed by it is laborious, and the separation of the grains from the stems is often imperfectly executed. As agriculture has advanced, attempts have been naturally made to substitute machinery which might perform the operation required with more facility and greater despatch. These attempts were but partially successful, until the invention of Andrew Meikle, an ingenious mechanic of Scotland, to whom, beyond a question, belongs the honour of having perfected the thrashing-machine. Changes and improvements have, indeed been made on certain parts of the original machine; but in all its essential parts, and in the principle of its construction, it remains as it came from the hands of its inventor.

In this machine, the unthrashed corn is made to pass between two revolving rollers. It is held firmly by these, which are of small diameter, and revolve with comparative slowness, while it is acted upon by a set of beaters, as they may be called, placed upon a cylinder, and revolving with great rapidity. The cylinder revolves upon a horizontal axle, while the beaters, consisting of bars covered with iron, are fixed lengthwise upon it, that is, parallel to its axis. The action of these beaters detaches the corn and chaff from the straw, and then, by means of revolving rakes, the straw is shaken, and the corn and chaff are allowed to separate from it. These fall through spars or wire-meshes into another machine, where they undergo the process of winnowing, while the straw itself is carried forward and thrown out of the machine by the action of the revolving rakes.

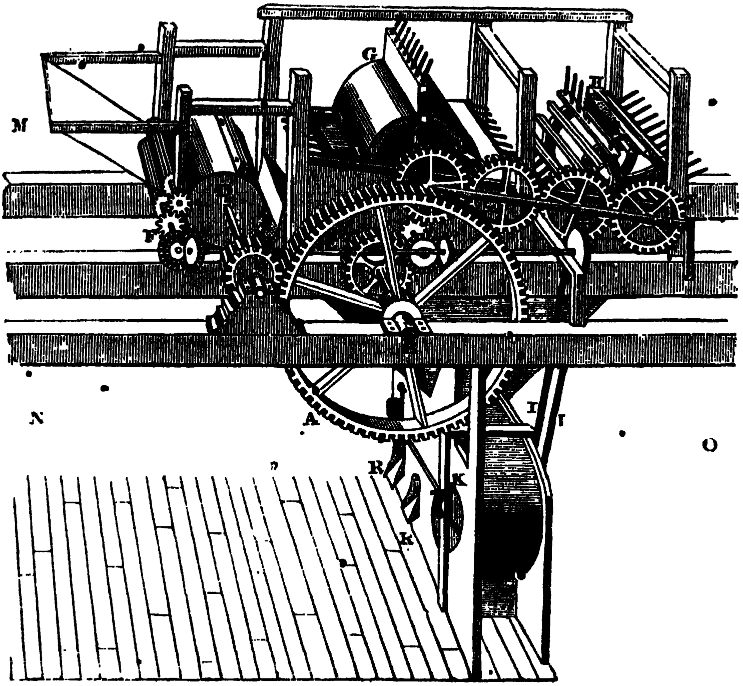
Fig. 42 represents a transverse section of these parts. In this, AA are two fluted cylinders of iron, working into each other, and between which the unthrashed corn is made to pass. B is the cylinder upon which are placed the four projections or beaters *cccc*. The cylinder revolving with great rapidity, the beaters act upon the unthrashed corn, as it is firmly held by



the fluted cylinders, and beat and detach the seeds and husks *from the stems. The whole passing over the cylinder, is thrown forward in the direction shown by the arrows x x x. It is first* acted upon and shaken by the four rakes EEEE, placed upon the hollow cylinder D, moving in the direction of the arrow *y*. It is then thrown forward, and acted upon by an equal number of rakes, placed upon the circumference of the sparred cylinder I, and by them it is thrown out at the end of the machine, at L. The bottom of the machine FGH, is so formed with spars, or a species of wire-work. that while the straw is carried forward by the action of the rakes, the detached grains of corn and chaff fall down in the direction of the arrows *zzzzz*, into a machine below, in which, by the action of winnowing, the chaff is separated from the grain. The first of the revolving cylinders D, is formed of thin iron, or of wood covered with tin. The second of the cylinders I, is of wood, sparred, so that any corn or chaff, not separated by the action of the first rakes, may fall through in passing over the last cylinder. The rakes at the circumference of this cylinder may have brushes fixed upon them, which sweep back any of the corn or chaff which may have fallen into the cavity at K, and in this manner the whole of the detached grain and chaff fall through the sparred or meshed bottom FGH.

The machinery of the thrashing-machine is driven by animal power, or by wind, water, or steam, variously applied. The parts described are within the apartment or barn in which the thrashing process takes place. The moving power applied is without the walls of the barn properly so called. The form of the thrashing parts of the machine is represented in Fig. 43, with the wheels and pinions employed in moving them. Here A is a large spur-wheel with its axle resting on the beam B. To this wheel, motion is communicated by means of the moving power without the barn, whether that shall be animal power, wind, water, or steam; and this wheel, by means of wheels, pinions, spindles, or belts, gives motion to all the parts of the machine. First, by acting upon the pinion C, it gives motion to the revolving cylinder D; second, by means of pinions, it gives motion to the horizontal shaft E, and this again, by means of

Fig. 48.



wheels, gives motion to the fluted cylinder F, and to the hollow cylinder G, with its four attached rakes. A wheel upon the axle of G gives motion to the two intermediate wheels *xx*, and these again to the wheel *y*, fixed upon the axle of the sparred cylinder H. Further, by means of the belt I I, placed upon a pully on the spindle E, motion is communicated to the winnowing machine K.

It is not easy in so small a figure to represent correctly these different parts. It must suffice here that the reader make himself acquainted with the essential parts of the machine, and the general means by which they are put in motion. The large spur-wheel A, he will observe, communicates motion directly to the revolving cylinder D. The same spur-wheel, by means of the spindle E, communicates motion, first to the two revolving cylinders between which the unthrashed corn passes, and second to the hollow cylinder G, with its series of rakes; and this again, by means of intermediate wheels, gives motion to the sparred cylinder H, with its several rakes; while, by means of a belt, motion is communicated to the winnowing-machine K, which stands below the sparred bottom of the thrashing-machine, and has the corn or chaff conveyed to it through a large hopper.

To understand further the general arrangement of the thrashing-machine, it is to be observed that the barn in which the operations of thrashing, winnowing, &c. are carried on, is divided into three apartments. M is the upper story of the barn, in which the unthrashed corn is placed. N, immediately underneath this, is an apartment for receiving the corn as it comes out of the winnowing machine at the apertures RR. O is the part of the barn into which the straw falls, and is called the straw-barn. Into the upper apartment M, the unthrashed sheaves of corn are carried from the barn-yard generally by means of an easy gangway on the outside. In the apartment N, which is called the dressing-barn, the corn is received from the winnowing-machine, and made ready for use. In the large straw-barn, the straw is generally piled up until it is required for the purposes of fodder or litter.

The thrashing-machine, it has been said, is driven by animal power, or by wind, water, or steam. The animal of draught is generally the horse, and from four to six are the numbers usually employed. The animals walk in a circular covered pathway, without the barn. Fig. 44 shows the manner in which they are generally attached, and the means by which motion is conveyed to the large spur-wheel within the barn already referred to.

A is a vertical shaft. BC is a large wheel with teeth working into the pinion D. This gives motion to the shaft E, and this again to the spur-wheel within the barn already referred to.

GGGG are vertical posts, descending from long beams HH, placed above the animals of draught. To these posts the animals are yoked by short chains attached to the collar, and, moving in a circular course, they give motion to the apparatus.

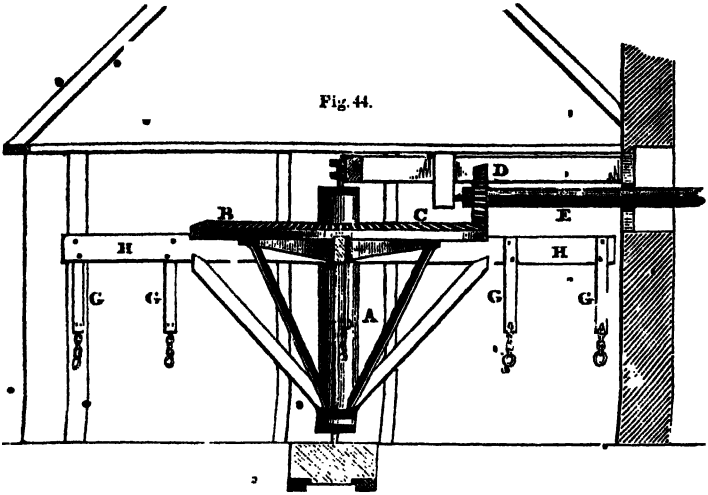


Fig. 44.

The number of horses employed, it has been said, is generally from four to six. The smallest class of machines is those in which only two horses are employed. There is always a waste of labour, however, when less than four horses are used. Whatever be the number employed, the operation of moving the machine is a severe one upon the working cattle, from the dead weight of the draught, and their confined position. For this reason, amongst others, the substitution of mechanical for animal power is always to be preferred where circumstances will admit of its application.

The mechanical power employed may be water or steam. Wind also may be employed, but this is too uncertain and unequal in its operation to be well suited for driving the thrashing-machine.

When water is the power employed, the common machinery of the water-wheel is used. Of the different powers, water, where it can be commanded in sufficient quantity, is the most economical.

But where water cannot be obtained, then the best resource is steam, which, from the great and steady power capable of being applied, admits of an admirable construction of the thrashing-machine. The steam-engine may either be a noncondensing or a condensing engine. The former is the most simple, and at its first cost the most economical: the latter, though more expensive, is the more perfect. The engine, according to the size of the farm, should be equal to a six or eight horse-power. The steam-engine for the thrashing-machine has now come into general use in the north of England and south of Scotland, where the farms are generally of the larger class.

Thrashing-machines driven by hand-labour have been often recommended, and in some cases constructed. But the machines of this class appear to possess no advantage over the flail, or rather to be much inferior to it with respect to economy of labour.

2. *Winnowing-Machine.*

The winnowing-machine is designed to remove the husks or chaff of corn from the grain, and to separate the impurities and loose refuse intermixed. With certain variations in the form of its parts, the principle of construction of this machine is in most places where it is used the same.

Four or more oblong boards of wood are fixed, at equal distances from one another, upon an axle, placed horizontally, and extending through the machine. This axle is driven round by a wheel acting upon a pinion, so that a rapid rotatory motion is given to the boards, and a current of air by this means produced. The corn to be winnowed is made to fall from a box or hopper, in the course of this current, through one or more sieves of wire, which, being kept in a quick lateral motion, intercept and scatter the grain, while the current of air acts in blowing away the chaff. The chaff being separated in this manner, the heavy grain falls down and is collected.

Figure 45 represents one side of the machine. A is a wheel driven by the handle B, and this wheel acting upon the pinion C, gives motion to an axle, on which are placed four oblong boards. To these boards, which are enclosed nearly all round, air is admitted from open spaces on both sides of the machine, as shown in the figure. These spaces may be enlarged or diminished by means of sliding boards, so that a larger or smaller quantity of air can be admitted.

Fig. 45.

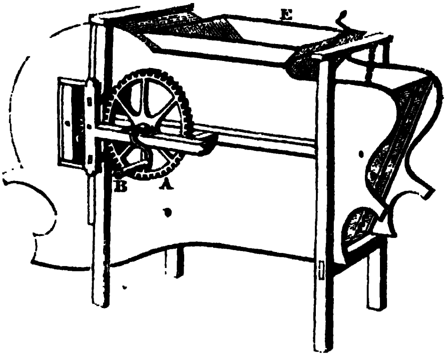
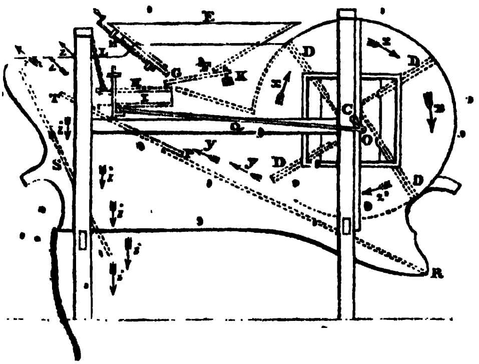


Figure 46 is the opposite side of the machine, and the occult lines represent a section of the interior. Here DDDD are four oblong boards, termed fanners, by the rapid motion of which in the direction of the arrows *x x x x*, a strong current of air is produced through the interior of the machine in the direction of the arrows *y y*. E, shown also in Fig. 45, is a hopper, into which the corn to be winnowed is put. The corn falls down from the hopper upon the sieves HI. These sieves are connected with the bottom of the hopper FG, which is moveable, and fixed to a hinge at K, and hung on two chains,

Fig. 46.



one of which, L, is seen in the figure. When motion, therefore, is given to the sieves HI, motion is at the same time given to the board KG, which forms the lower part of the hopper. The shaking motion given to this board causes the corn in the hopper to fall through upon the sieves by the aperture at G. By means of the screw M, a sliding board is made to be raised or pushed down, so that a greater or less aperture shall be left at G. The lateral or shaking motion is given to the sieves and bottom of the hopper by means of the rod Q, which is connected by one crank with sieves, and by another crank O with the axle C, to which the fanners are attached. The bottom of the machine TR, formed of boards, is placed obliquely, so that the corn, after having passed through the sieves, shall fall along the inclined plane from T to R. A part of this bottom is perforated like a sieve, so that dust, sand, and other impurities, shall be separated from the corn as it falls from T to R. A portion of this bottom also PT is made to slide. A board S, extending across the machine behind, is made to slide up or down, and all the space *z z z* is open.

The manner in which the machine acts will now be understood. A person drives the handle, and so gives motion to the fanners within. The corn to be winnowed is lifted up, placed in the hopper, and continually supplied as it falls through. It falls through the aperture G, which it has been seen can be enlarged or diminished, upon the two parallel wire-sieves HI. In the mean time, the current of air acting upon it, the chaff is blown out at the end of the machine in the direction of the arrows *zzz*. The heavy corn falling down the inclined bottom comes out at R. Should any of the corn be so light as to be blown past the point T, but yet not be sufficiently light to be blown away with the chaff, it falls down in the intermediate space in the direction of the arrows *ii iii*, separately from the heavy corn. By pushing upwards the sliding board PT, a smaller quantity of this lighter corn is separated, or, in other words, a larger portion of it falls down mixed with the heavy corn. By elevating the board S, a smaller quantity of lighter corn is blown away with the chaff.

There are differences in the form of this machine. Thus in place of two sieves one above the other, one may be rendered sufficient. The heavy corn, in place of falling out at the end at R, may be made to fall out at a spout at the side; and, in like manner, the light corn, in place of falling down below the machine, may be discharged by a spout. This is the construction adopted when the machine is attached to the thrashing machine. Sometimes the bottom PR is made moveable, so that a shaking motion may be given to it for the better causing of dust and sand to fall through. The machine when not attached to the thrashing apparatus is made so light as to be readily moved from one part of the barn to the other.

V. IMPLEMENTS FOR PREPARING FOOD FOR LIVE-STOCK.

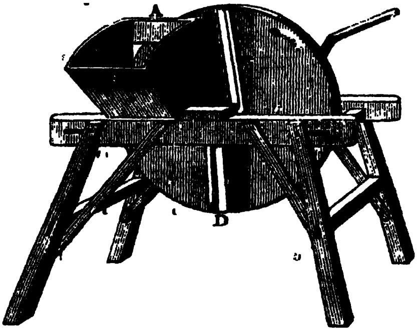
In many cases, it is beneficial to prepare the food to be used by the animals of the farm in various ways. The first to be mentioned of the class of implements employed for this purpose, is that for cutting the roots of turnips and other plants into pieces, that they may be the more readily eaten by sheep and oxen.

1. *Turnip-slicer.*

Various machines have been constructed for this purpose. The most common and simple is that formed by means of knives placed upon a fly-wheel, and made by each revolution to cut slices from the turnip or other roots. The parts to be cut are placed in a box open at the top and one of the sides. A large wheel, covered with boards, is set upon a frame-work, in such a manner as to cover the open side of the box or hopper, so that, when the roots are put into it, they press upon the side of the wheel. In the wheel are placed two knives, at equal distances from each other, and extending nearly from the centre to the circumference. At every revolution of the wheel, each of these knives makes a stroke upon the roots, which are pressing upon the wheel at the open side of the hopper, and cuts off a slice. An aperture is made through the entire wheel, corresponding with, and of the length of, each knife, so that, when the slice is cut off, it passes through this aperture, and falls down on the other side of the wheel. The wheel is driven by a handle, and roots being constantly filled into the hopper, the process of slicing is carried on.

In the following figure, AB represents the hopper in which the roots to be cut are placed: CD represents the large wheel formed of boards, and which covers the open side of the hopper: E and G are the cutting-knives, extending nearly from the centre to the circumference of the wheel. The apertures corresponding with these knives, extend quite through the wheel. At every stroke of the knife the slice cut off passes through the aperture, and falls down on the other side. One person drives the wheel by a handle, and another fills the roots into the box. A basket or other vessel may be placed for receiving the slices as they fall.

Fig. 4



This machine is exceedingly well adapted for cutting the roots of turnips and mangel-wurzel for oxen. But when sheep, and especially young sheep, are to be fed in spring, and when their teeth are loose, it is often better to cut the bulbs not only into slices, but to divide them into smaller pieces still, that they may be the more readily taken up by the animals. The machine described may be easily made to cut the roots in this manner. A series of sharp projections are to be placed upon the wheel, just before the apertures, so that the root may be cut by these before it is acted upon by the cutting-knife. By this means the roots are cut not only into slices, but into pieces proportioned to the distance at which these sharp projections are placed from one another.

Other machines may be used for performing the same operation. The following figures, 48, 49, and 50, represent a machine of this kind. Upon a square frame, there is placed a hopper, A, figure 49, in which the roots to be acted upon are put. Forming a moveable bottom to this hopper, is a series of iron bars, or grating, to which an alternate motion is given by means of a crank C, formed on the shaft of the fly-wheel E. Fig. 49 shows a front view of the grated bottom, at the top of which is a rail *a*, placed at a little distance from it. This rail is sharpened so as to form a knife. Fig. 50 shows a section of the grated bottom with the knife *a*, and a series of studs *d*, between the horizontal knife and the grating. These studs are sharpened so as to form a set of knives placed vertically. Thus there are two sets of knives, the first *a*, which makes a nearly horizontal stroke, and the second *d*, which makes strokes at right angles to the last. The roots on

Fig. 48

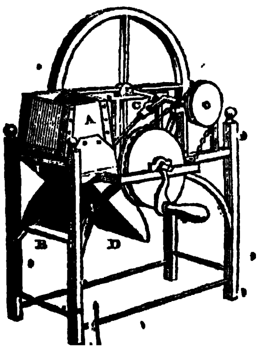


Fig. 50.

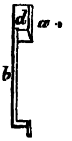
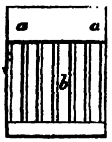


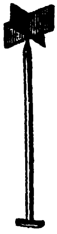
Fig. 49.



being cut fall through the bars upon the spout D, Fig. 48, and so are collected.

A very easy mode of cutting turnips into pieces for cattle is by an instrument (Fig. 51) with four blades at right angles to one another. The turnip or other root is struck as it lies upon the ground, or in the feeding-trough, and thus at one stroke is divided into four parts.

Fig. 51.

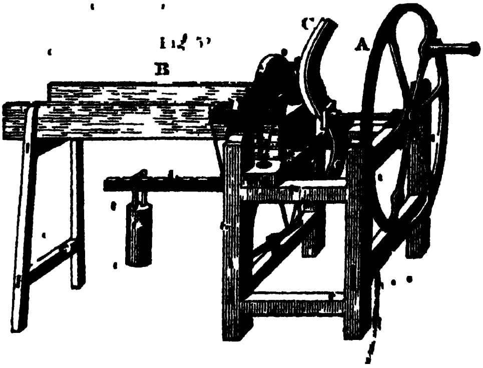


2. *Chaff-Cutter.*

The chaff-cutter is a machine employed for cutting hay and straw into pieces of a given length. By this process, it is found that the dried stems of plants can be more easily consumed by cattle, and, therefore, afford more nutriment.

In this class of machines, the hay, straw, or other substances to be cut, are placed in a narrow oblong trough. They are then pressed forward to two revolving cylinders, which, while they hold them with firmness, gradually carry them through. They are then acted upon by one or more knives, sometimes placed upon a fly-wheel or its axle, and sometimes on another wheel, to which motion is conveyed from the fly-wheel. At each stroke of these knives, a portion of the straw or other substance is cut off of the length required, as from half an inch to an inch. The desiderata in the construc-

Fig. 52.



tions of these machines, are,—causing the knives to make the stroke in the most efficient manner, which is done by placing them in an oblique position, causing the straw or hay to be brought forward, to be acted upon by the knives with regularity, and so adapting this to the several strokes of the knives, as to vary the length of the cut according to the degree of fineness to which it is wished to reduce the stems.

The foregoing figure represents a machine formed with a regard to these principles. Upon the axle of the fly-wheel A are fixed the knives CC, and B is the trough in which are placed the straw and other substances to be acted upon. These are brought gradually forward by two smooth cylinders, to which motion is given by the wheel A. As the stems come out of the box in proportion as they are brought forward by the cylinders, they are acted upon by the knives, and cut into pieces of the length required. The manner in which the stems are brought forward in the precise degree necessary, so as that they may be cut of a given length, could not be explained without sections of the different parts of the machine; but the figure will give an idea of its general form and mode of operation.

3. *Machine for Bruising Grain.*

A machine is used occasionally for bruising seeds, as of pease, beans, or oats, intended for the food of animals, and thus rendering the mastication more perfect. There are different forms of these machines. They are sometimes driven by the hand, though this is better done by a power attached to the thrashing-machine, or, where this is not convenient, by a single-horse power. Perhaps the best construction of this class of machines is that of two plane rollers of large diameter, kept in rapid motion, the corn to be bruised being supplied from a hopper, so as to pass between them.

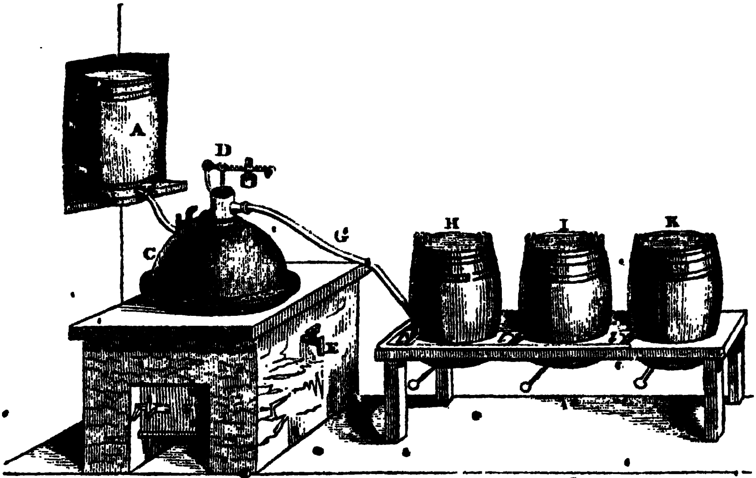
The machines driven by the hand are convenient, as being portable; but the labour of driving them is considerable, and all the purposes of such machines may be served by having the seeds coarsely ground in any common corn-mill.

4. *Apparatus for Boiling or Steaming Food.*

In numerous cases it is found to add to the nutritive properties of roots and grain to boil them before they are given to animals. The most economical method of preparation is by heating the water by means of steam, conveyed from the boiler to the vessel containing the roots or grain.

Any kind of wooden box or barrel will answer for this purpose, so formed as to admit of being readily filled and emptied. The steam is to be conveyed in a pipe to the lower part of the vessel, which ought to have a sliding board at the bottom to allow the contents to be discharged when ready. The vessel may be filled with water, though this is not necessary in the case of succulent roots as the potato, because the steam is quickly condensed. But when corn is to be boiled, it should be covered with water that the steam may be condensed.

The following figure represents a steaming apparatus of a sufficiently good construction.



A is a barrel or other vessel for containing water and supplying it to the boiler C. D is a safety valve. At the upper part of the boiler are placed two tubes, with stop-cocks. One of these tubes terminates near the bottom of the boiler. Upon the stop-cock being turned, water should always issue from this tube. When, therefore, steam issues from it, and not water, this indicates that the water is too much boiled away, and consequently that there is a deficiency of water in the boiler. The other tube terminates within the boiler near the top. Upon the stop-cock being turned, therefore, steam ought always to issue forth. But should water in place of steam come out, then it will appear that the boiler is too full of water. In this manner the attendant, by turning either stop-cock, ascertains whether there is a deficiency or excess of water in the boiler. The quantity of water could indeed be regulated by nicer means; but that described will be found sufficient in practice. F is the furnace, and E is a pipe with a stop-cock communicating with the boiler. When it is wished to obtain hot-water, it is obtained by this pipe. A pipe G communicates with the barrels H, I, K, and conveys the steam to them; and in these is placed the food to be steamed. By means of the stop-cocks *l*, *l*, *l*, the communication can be cut off with any of the barrels, so that the steam may be admitted to one barrel or two barrels, or three, as may be wished. The barrels in the figure are three, but the number may be extended. Each barrel has a moveable lid, which is kept down by screws, and a sliding board below, by which the food, when ready, is withdrawn. The barrels are raised on a frame, so that a wheelbarrow or vat may be placed below, and the food at once emptied into it.

By means of an apparatus of this kind, roots and other parts of plants may be steamed in a convenient and economical manner.

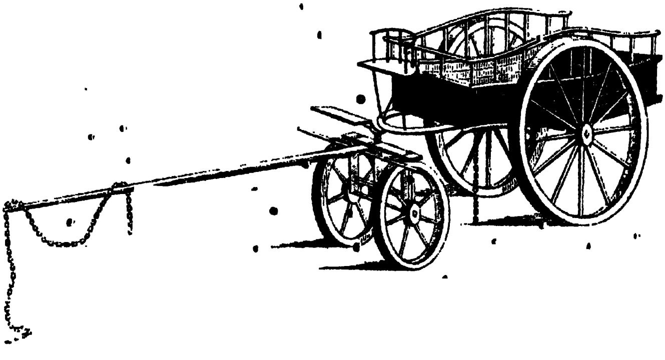
VI. WHEEL-CARRIAGES.

The carriages employed by the farmer are moved either by hand-labour, as in the case of barrows of different kinds, or by the working cattle of the farm.

The carriages of the latter class are either carts on two wheels, or waggons on four. Those of either kind have their advantages, and in certain kinds of work each may excel the other.

When the object is the conveying of heavy and bulky substances, as hay and corn, the waggon has this advantage, that a greater number of animals can be employed to move one load.

No waggon, however, for the purposes of the farm, ought to require a greater force of draught than two horses; and in order that the horses may exert their force in the most advantageous manner, they should be yoked abreast, and not one before the other, according to the common practice. They should be so attached, too, as that each, pulling upon the collar of the other, should exert an equal force in drawing. In order that the waggon may turn with facility, the fore-wheels are generally made considerably smaller than the hind-wheels, as we see in coaches and chariots, so that they may turn below the bottom of the carriage. By this diminution of the size, however, the force required to draw the waggon is increased, both by the comparatively greater friction on the axle of the smaller wheel, and by the greater difficulty of pulling it over obstacles. For these reasons, the fore-wheels should either be kept as large as is consistent with the facility of turning, or placed a little in front of the body of the carriage, so that a smaller



proportion of the weight shall press upon them. The preceding figure of a waggon, described by Sir Alexander Gordon, shows this latter principle of construction.*

Although the waggon, under certain given circumstances, possesses advantages of its own, it is yet inferior to the single-horse cart for the more common purposes of the farm.

In the single-horse cart, the horse partly bears the load and partly drags it. In this manner, it is believed that it can be shown that the horse can move a greater weight, at least for moderate distances, than when he exerts his force solely in pulling. The single-horse cart, therefore, in this excels the waggon, that, for moderate distances, a greater comparative weight can be drawn by an equal exertion of animal force. And it possesses this further advantage over the waggon, that it is more readily turned, backed, and otherwise managed, so that a considerable saving of time is effected by employing it in most of the common operations of the farm.

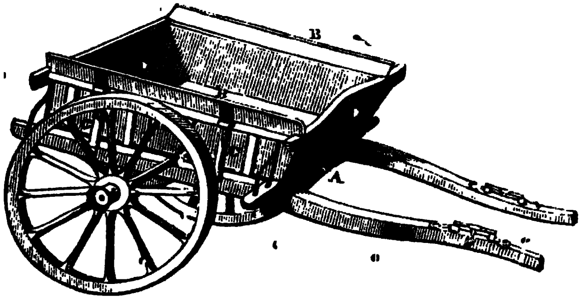
The objections to the use of the cart for the carriage of loads exist when the roads are very bad, and the carriages very distant: in either case the horse is distressed by the pressure of the load, and his own confined position in the shafts. But, where the roads are good, this objection does not apply: and experience shows that a greater weight can be drawn for an equal distance by the same number of horses in carts than in waggons of the common construction.

But two horses may be employed to draw the cart, one being yoked before the other. In this case, however, a considerable loss of power results from the manner in which the fore-horse is necessarily attached to the carriage: for, by ceasing to exert his force even for the shortest time, he throws the whole burden upon the shaft-horse; and when, after a temporary relaxation of draught, he makes an exertion, it is effected by means of a start or jerk, which distresses himself as well as the shaft-horse; and as he frequently pulls in a line of direction somewhat different from that of the shaft-horse, a part of the force exerted is lost, and becomes a pressure upon the back of the latter. Hence, although the fore-horse frequently throws the whole labour of draught upon the horse behind, yet, by exerting his force solely in pulling, without bearing any portion of the weight, and by the starts and jerks to which he is subject, he is almost always found to be more distressed on a journey, or by any continued work, than the horse on which the burden falls more constantly and equally.

---

* The waggon may be also used with a single horse. Sir Charles Monteith, a gentleman distinguished for his mechanical knowledge, has long employed the single-horse waggon, and prefers it to every other carriage for the purposes of ordinary draught. He has adopted the great improvement of a drag, formed by making a bar of wood bear against the periphery of the wheels, by means of screws working through the back bar of the waggon. In this way, the driver has the waggon under his control in descents, much more effectually than by means of the chain commonly used.

The following figure represents the single-horse cart; but the same form of construction is adopted when two horses are employed. This is termed the close-cart, in contradistinction to the other, to be afterwards described, employed in the carriage of hay, corn in the straw, and other bulky articles, and usually termed the corn-cart.



The body of the close-cart may be fixed to the shafts, or so formed as to be raised independently of them, when it is termed a turn-up cart. It is made in this manner in order that the body may be raised so as to discharge the load from behind. The body turns upon the axle, and is kept attached to the shafts by a hook at A. The hook being disengaged, the body of the carriage may be lifted up, the horse remaining in the shafts. When this method of construction is not adopted, but when the body is fixed permanently to the shafts, it is necessary, when loads are to be discharged behind, that the horse be disengaged from the shafts and the whole lifted up. This appears to be very awkward, and yet in practice it is found to be attended with no inconvenience. The carter, by taking hold of the end of a shaft, has a more powerful lever to elevate the cart than in the case of the turn-up cart, while the cart itself is made more light and compact: and with respect to unloosening the horse in the shafts, this is done in a time almost as short as in elevating the turn-up cart.

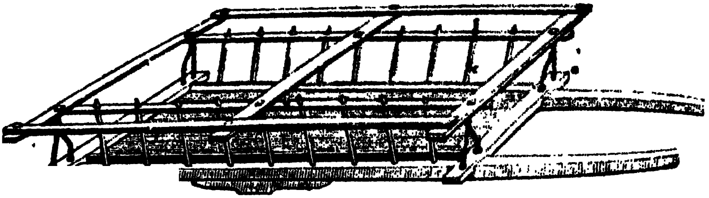
In every cart the hinder board is made to be detached for the purpose of discharging the load, or placing it more easily in the carriage. Two boards BB, removeable at pleasure, are placed one upon the edge of each side of the cart, for the purpose of better supporting the load when bulky. They are fixed by long handles at C, C passing through iron staples on the outside of the cart.

In using the single-horse cart in journeys, one man drives two carts. The horse of the last cart is fastened by a rope from his bridle to the cart before; and he soon learns to follow steadily and quietly in the same track.

The other form of the cart is that represented in Fig. 56. This species of cart is sparred at the sides, and is formed in this manner for the purpose of carrying loads of corn in the straw, hay, and similar bulky commodities. It is generally made of such dimensions as to be drawn by two horses, one yoked before the other. The reason of this is, that from the nature of the load, one man can drive only one cart, so that if one man, by the practice of the farm, has two horses, an additional person will be required for driving the second cart. For this reason it is generally thought better that two horses should be used, though to a disadvantage as to the power of draught.

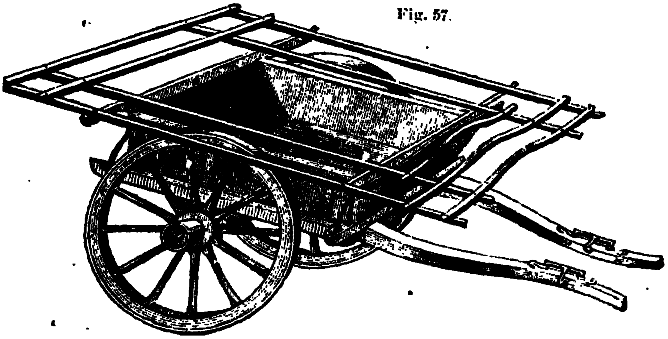
Where this practice prevails, it is not necessary that there be a separate axle and wheels for the cart. It is only used occasionally, and when this occurs it is placed upon the axle and wheels of the close-cart. Thus, the simple arrangement is, when hay and the like are to be driven, the close body is removed, and the sparred one placed upon the same wheels.

Fig 56.



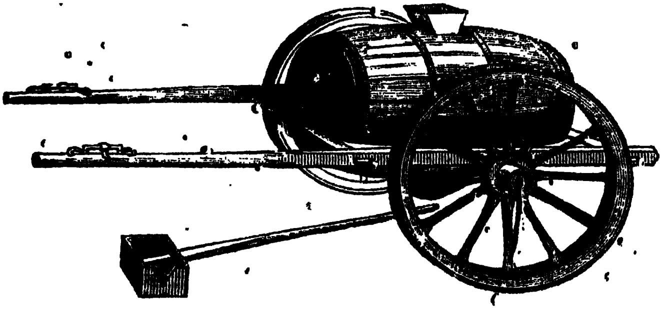
It is very convenient to have a sparred frame to be attached to the close-cart. By this means, when occasion requires, it may be employed for the same purposes as the larger sparred or corn-cart.

Fig. 57.



It is often convenient and necessary upon a farm to have a carriage for the conveyance of water. This may consist of a large barrel, placed upon the frame of a common cart. In order that the barrel may not be too high, the axle may be bent as shown in the figure.

Fig. 58.



The manner in which the animals of draught are attached to these carriages is very simple.

On the back of the shaft-horse, Fig. 59, is placed the cart-saddle; which is formed with a raised groove A, over which a chain to be attached to the shafts passes. This chain is fixed on each side to a hook moveable along an iron staple B, fixed upon the shafts. To the same staple are fixed two other hooks. To one of these is attached a chain C, which is fixed to the collar of the animal, and by means of which he exerts his force in pulling: to the other hook is fixed the breech-chain D, attached to the leather-belt G, by means of which the horse is enabled to resist the descent of the load when going downhill, and to back the cart. Thus to the iron staple there are attached the collar or draught-chain, the back-chain, and the breech-chain. A band E then passes beneath the horse from shaft to shaft, which prevents the shafts from being raised up by the weight. The bridle of the horse is a single snaffle, to the rings of which, on each side, are fixed the reins by which the driver guides him. These reins pass through rings upon the collar. When the horse is to be unyoked, the bellyband is unloosed, and the collar and breech-chains unhooked.

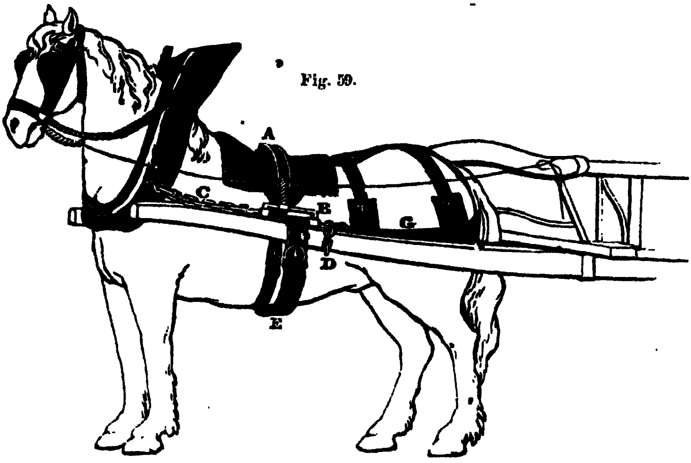


Fig. 59.

When another horse is used, he is yoked by chains fixed near the ends of the shafts; and, to keep the chains asunder, a bar or stretcher is fixed between them. The trace-horse has no cart-saddle, having no weight to bear upon his back, and he has no breeching, since he has no power of backing or resisting the descent of the draught. A band, and sometimes two, pass over his back to support the chains. A band also passes beneath his belly to keep the harness in its place. The chains are attached to the collar. The bridle, as in the case of the shaft-horse, is a snaffle, to the rings of which are attached the reins.

VII. UTENSILS OF THE DAIRY.

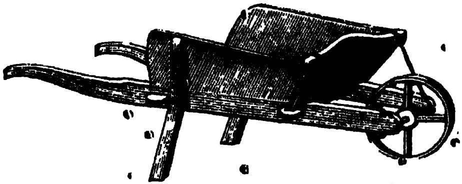
The utensils required for the dairy consist of vessels for containing milk, of churns, of cheese-presses, &c. These form a class which will be most conveniently treated of when describing the works of the dairy.

VIII. IMPLEMENTS OF MANUAL LABOUR, &C.

These form a numerous class; but it will be here necessary to refer to only a part of them. The remainder will be more conveniently described when reference is made to the labours in which they are employed; and an enumeration of the whole which are necessary upon a farm will be given under the head Capital.

1. *Wheelbarrow.*

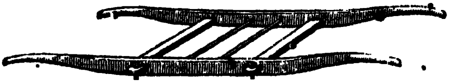
Fig. 60.



The wheelbarrow is employed for the carriage of light loads, as of earth, for short distances, lime for building, and the like.

2. *HANDBARROW.*

Fig. 61.



This species of barrow is, under certain circumstances, substituted for the wheelbarrow for short distances.

3. *SPADE, BROAD-POINTED SHOVEL, AND NARROW-POINTED SHOVEL.*

Fig. 62.

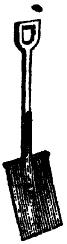


Fig. 63.

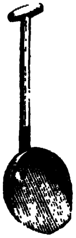
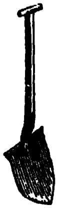


Fig. 64.



The spade here shown is the common spade: the broad-pointed shovel is chiefly used for the spreading of lime: the narrow-pointed shovel for the throwing out of loose earth from ditches, furrows, and drains, and for various other purposes in conjunction with the spade.

4. *MATTOCK, PICKAXE, AND FOOT-PICK.*

Fig. 65.

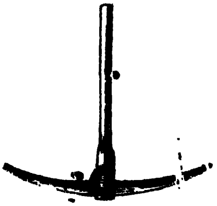


Fig. 66.

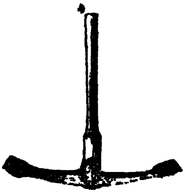
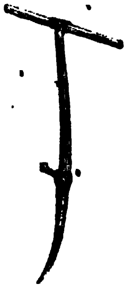


Fig. 67.



The mattock, Fig. 65, is used for forcing up stones, breaking hard ground, and the like: the foot-pick, Fig. 67, is employed for similar purposes: and the pickaxe, Fig. 66, is made for cutting substances, as the fibres of the roots of trees, as well as for forcing them up.

5. *Saw, Axe, Sledge, and Hammer.*

Fig. 68.

Fig. 69.

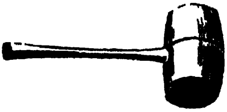
Fig. 70.

Fig. 71.

These implements differ in nothing from similar tools in common use.

6. *Mall.*

Fig. 72.



The mall is employed for driving posts, piles, and the like into the ground.

7. *Three-pronged Forks.*

Fig. 73.

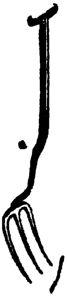
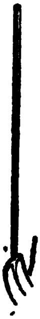


Fig. 74.



The larger fork, Fig. 73, of this class is used for the lifting of dung into carts and the like; the small fork, Fig. 74, chiefly for the spreading of dung upon the ground.

8. *Forks, long and short.*

Fig. 75.

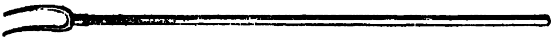


Fig.

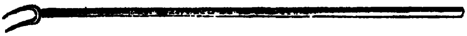
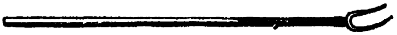


Fig. 77.



The forks of this class differ from the last in the uses to which they are applied: Fig. 75 is used for forking straw and other substances to a height: Fig. 76 for forking the sheaves of corn into carts or waggons: and the smaller fork, Fig. 77, is used in the stable, and for numerous purposes.

9. *Hay-Rake.*

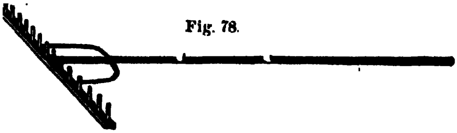
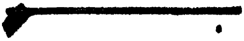


Fig. 78.

The hay-rake is employed in raking the surface of ground, for the purpose of collecting loose hay, straw, stalks of corn, &c.

10. *Hand-Hoe.*

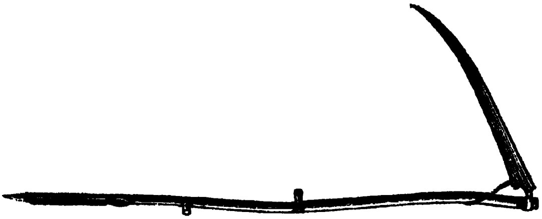
Fig. 79.



The hand-hoe is employed in the cultivation of turnips, potatoes, and other plants.

11. *Scythe.*

Fig. 80.



The scythe is used for mowing hay, green forage, corn, and the like.

12. *Dung-Drag and Mud-Scraper.*

Fig. 81.

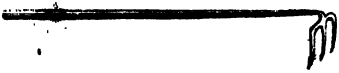
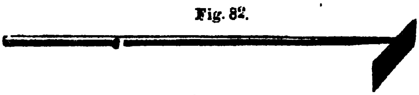


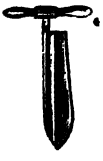
Fig. 82.



The dung-drag is used chiefly for the dragging of dung from carts: the mud-scraper is used for collecting substances on the ground, as mud, dung, &c.

13. *Hay-Knife.*

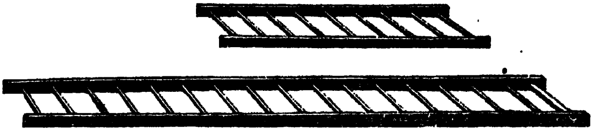
Fig. 83.



The hay-knife is employed for cutting off portions of hay from the compressed mass of the hay-stack.

14. *Ladders, long and short.*

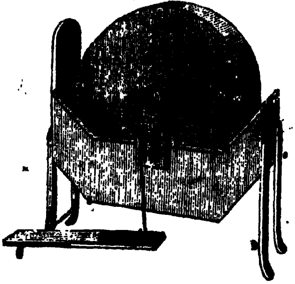
Fig. 84.



The ladders of the farm are of different sizes, according to the uses to which they are applied: they may be of the respective lengths of 24, 16, and 8 feet.

15. *Grindstone.*

Fig. 85.



The grindstone is best made to be moved by the foot, and may have a trough beneath, in which water is to be put to keep the stone moist when working.

16. *Utensils of the Stable,—Currycomb, Brush, Mane-Comb, Foot-Picker, and Scissors.*

Fig. 86.

Fig. 87.

Fig. 88.

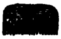


Fig. 89.

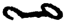
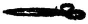


Fig. 90.



17. *Weighing Machines.*

A common balance for weighing wool and similar substances is necessary upon a farm; and sometimes other weighing machines, and particularly one for weighing large loads, as hay.

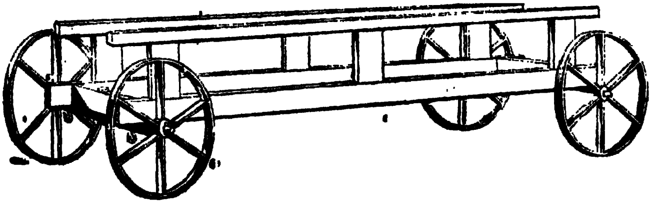
18. The Utensils of the Barn will be afterwards described.

19. The Hedger's Tools will be described when the operations in which they are employed are treated of.

20. There is a mixed class of implements, consisting of pails, &c., which need not be represented. They will be enumerated under the head Farming Capital.

It is often convenient to have upon a farm a truck, with four low wheels, for the purpose of carrying ploughs, harrows, and other implements, along roads.

Fig. 91.



IV. SIMPLE OPERATIONS OF TILLAGE.

I. PLOUGHING.

In ploughing it has been seen, a slice of earth is to be cut from the left-hand side, and to be turned over to the right-hand side. In this operation the left-hand or near-side horse walks on the ground not yet ploughed, the right-hand or off-side-horse walks in the furrow last made, and the workman follows holding the handles of the plough. By means of these handles he guides the plough, and he directs the animals of draught by the voice and the reins. When he is to turn the plough at the end of a ridge, or when it encounters an obstacle, as a large stone, he presses down the handles, so that the heel of the plough becomes a fulcrum, and the share is raised out of the ground.

In ploughing, the instrument ought to be held vertical. If it is inclined to the left-hand side, the same work is performed in appearance, though not in reality; a portion of the ground below not being tilled at all, but left thus—

Fig. 92.

The plough is of the most perfect form when its various parts are so adjusted that they shall not oppose each other's motion: but it is very difficult to form a plough that is perfect in the form and combination of its parts. Even in those of the best construction, there is frequently found to be a tendency to rise out of the ground, or to turn to one side, generally the right-hand or open side. The tendency to rise out of the ground can be corrected by giving an inclination downwards to the point of the share; and the tendency to turn to the open or right-hand side can be obviated by turning the point of the share slightly to the left-hand side. By these means, however, the labour of draught is increased, and care must therefore be taken, that this tempering of the irons, as it is frequently called, be not in any case carried further than is necessary to correct the defects of the instrument. All that is necessary beyond this is effected by changing the position of the line of draught by means of the bridle on the beam.

With regard to the depth to be ploughed, this, we shall see in the sequel, depends upon the kind of crop to be cultivated, and other circumstances. It has been shown that a furrow-slice of ten inches in width requires a depth of seven inches; that is, a depth of about two-thirds of the width, in order that it may lie at an angle of 45°. But although it is necessary to proceed upon this principle in forming a plough, we cannot regulate the depth to the width in this manner in practice. It is not necessary that the depth should be to the width in the proportion of two to three, or that the sod should lie precisely at the angle of 45°. In the field all that can be arrived at is a kind of approximation to the true proportions. When the sods are considerably too wide in proportion to their depth, the ploughman will be admonished of this by their lying too flat, and too slightly overlapping one another. When their depth is considerably too great in proportion to their width, they will stand too upright, and be apt to fall back again into the furrow.

The medium depth of good ploughing may be held to be seven inches. When circumstances, as the kind of crop and the nature of the soil, do not require deep ploughing, the depth may be less: but it will be considerably more in those cases, to be afterwards adverted to, where deep ploughing is from any cause expedient.

In the moist climate of this country, and indeed in most others of Europe, it is common to form the ground into what are termed ridges, so as to admit of the water which falls upon the surface finding a ready egress. And even in lands so dry that little injury will result from stagnating water, such ridges are generally formed on account of their convenience in the different works of tillage.

The first operation in the forming of ridges is *striking the furrows.*

Let it be supposed that the field has been laid level by previous ploughings, and that the marks of former ridges being obliterated, the lines of the new ones are to be laid out. The usual breadth of ridges is from 15 to 18 feet, and sometimes more. We may assume in the following descriptions 15 feet to be the width of the ridges.

Let a steady ploughman be furnished with three or more poles of wood, shod with iron, 8 or 9 feet in length, and divided into feet and half feet. The first operation is to mark off at two sides of the field what is termed a head-land. This is merely a ridge formed parallel to the side of the field on which the horses are to turn, to afford sufficient space for which, these ridges may be 18 feet wide. The lines of them are marked off before the other ridges, in order that the ploughman may know, on arriving at the end of the ridge, when to turn his horses. After the rest of the field is ploughed, the head-lands themselves are ploughed, and formed into ridges.

In the following diagram, representing a field, let EF, GH, represent the lines of the head-lands, drawn parallel to AB and CD, the sides or boundaries of the field, and at the distance from each of these sides of 18 feet. These lines the ploughman marks out, by running a straight furrow with his plough parallel to the two sides.

Let him now, beginning at the side of the field AD, parallel to which it is intended to run the ridges, measure off with his pole E*a*, 7½ feet. At the point *a* let him place one of his poles. This is the point at which he is to *enter* his plough. But, leaving his horses in the mean time, let him walk on to a convenient distance, as to 1, and there, in like manner measuring off 1 *b*, 7½ feet, let him set up his second pole at *b*, and then, at the further end of the field, on the line of the head-land, at *c*, let him place his third pole. He has now three poles placed in a line; but if, from the length of the field or inequalities of the surface, more than three poles are necessary, more must be used, as there must be so many poles in sight as that the ploughman may be enabled to direct his plough by means of them in a straight line. He now returns to his plough and enters it at the first pole at *a*, keeping the other two poles in a line, so that he may be enabled to plough directly towards them. Having entered his plough at *a* he stops his horses, and measures off 15 feet to *d*, where he plants the pole. He then returns to his plough, which is standing at *a*, and drives his horses, keeping the two poles before him as a guide, to the second pole *b*. Having done this, and leaving his plough standing at *b*, he measures off from *b* to *e*, 15 feet, and there he plants his pole. He then returns to his plough, and proceeds forward, making his furrow in a straight line to the last pole *c*, where, in like manner, he stops his horses, and measuring off 15 feet, he plants his pole at *f*.

In this manner he has placed his poles in a straight line, at the distance of 15 feet from their last position, and parallel, as before, to the line of fence. He now turns his horses sharp about, and returns by the furrow which he has just drawn *cba*. By this second ploughing he throws the earth out in an opposite direction, so that he has formed a completely open furrow. In returning, he takes care to correct any inequality or crookedness that may have taken place through the unsteady motion of the horses in his first track.

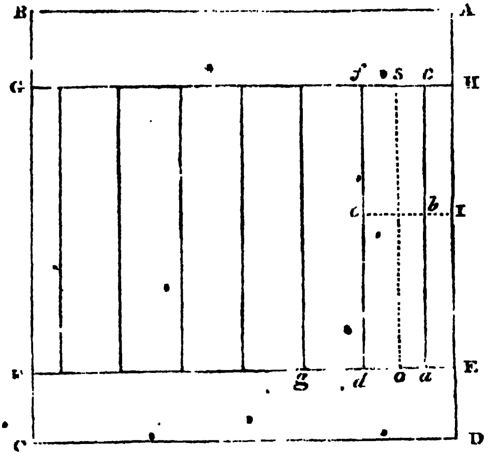
The poles being now placed in a line, *def*, he brings his plough to *d*, enters it and stops it there. He measures off 15 feet with his pole from *d* to *g*, and fixes his pole at *g*; and then he proceeds with his plough to *e* and *f*, repeating the same operation with his pole as before, and returning by the track of his last-made furrow from *f* to *d*. In this manner he proceeds throughout the whole field forming parallel open furrows, at the distance from one another of 15 feet. These furrows are to form the *centres* of the future ridges.

The field is now prepared for being ploughed into ridges, and the manner of doing so is this:—

The ploughman beginning at the left-hand side of the open furrow, ploughs his first furrow-slice towards it. He then, returning by the opposite side, performs the same operation, causing the two first furrow-slices to rest upon one another.

Thus, in forming his first ridge, he begins at the side of *a*, and, ploughing in the direction from *a* to *c*, he turns his first furrow-slice into the open furrow *a c*. When he arrives at *c*, he turns his plough right about, and, returning from *c* to *a*, he lays his second furrow-slice upon the first one, as at C, Fig. 94. In this manner he continues always turning to the right-hand side, and laying his furrow-slices towards the centre of the ridge, until he has reached the boundary of the ridge EH, on the one side, and the line *os* half-way between *ca* and *df* on the other. He has thus formed a ridge, of which *ca* is the crown or centre, and HE and *os* the termination. By proceeding in this manner throughout the field, the whole is formed into ridges, of which the first marked furrows are the centres.

Fig. 93.

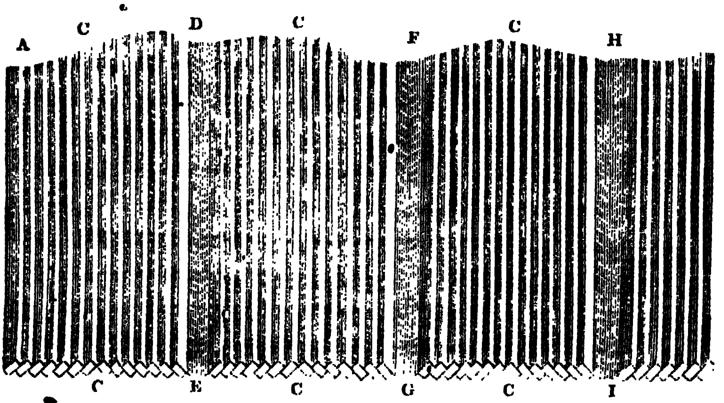


It has been said that the ploughman continues turning his horses to the right, and that thus, after having proceeded from *a* to *c*, he returns from *c* to *a*, and so on, always ploughing round *ac* as a central line. When, however, he has proceeded from *a* to *c*, he may turn his horses left about, and return from *f* to *d*, and so on, always laying his furrow-slices towards *ac* and *fd* respectively. In this manner he will have ploughed the half of two adjoining ridges, and terminated at the space *os* half-way between them. This method of ploughing, it will appear, has the same effect as turning the horses right about, and is the most frequent and convenient in practice.

In the following figure, in which CC, CC, CC, are the centres of the ridges, the manner in which the successive furrow-slices have been laid upon one another is shown.

By this laying of the earth towards the centres, the ridges acquire a certain curvature. By ploughing the earth away from the intervals AB, DE, FG, HI, the ground is hollowed at these parts, which now form the *open furrows.* It is by these open furrows that the water which falls upon the surface finds a passage.

Fig. 94.

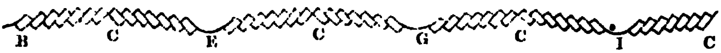


A certain, though not a great degree of curvature, is given to the ridge by this ploughing. It is frequently, however, necessary to give it a yet greater degree of curvature and elevation. This is done by ploughing the whole ridge a second time, and in a similar manner.

The plough is first driven along the centre of the ridge from C to C forming an open furrow. Successive furrow-slices are then laid towards this furrow, in the same manner as in the previous ploughing. This is done with the successive furrow-slices, until the plough reaches the open furrows AB, DE, FG, HI. In this manner the whole ridge is ploughed, and an increased elevation and curvature given to it. This operation is termed *gathering.*

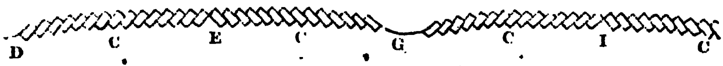
In performing the operation of gathering, it is important that the ridge be formed with a uniform curvature, so that it shall not have what is technically termed a shoulder, or hollow part on each side of the crown. It is to prevent this defect that the open track is made along the crown before the first two slices are laid together; by which means the ploughman is better enabled to lay them upon each other in such a manner that they shall not overlap and form a protuberance at the crown of the ridge. A transverse section of the ridges, when gathered, will appear thus:

Fig. 95.



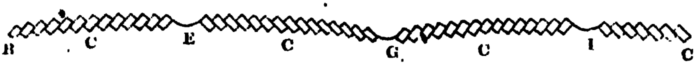
A ridge, however, being already formed, it may be wished to plough it again, and yet to preserve it at the same curvature and elevation. In this case, the plough is to enter at the open furrow, and to lay the successive furrow-slices towards it, until the two adjoining ridges are ploughed. By this means all the slices of the same ridge lie in the same direction, and the curvature and elevation of the whole remain as before. This operation is termed *casting*, and the manner in which the furrow-slices rest upon each other will appear in the following figure.

Fig. 96.



In the operation of casting, two methods may be pursued. The two first furrow-slices, as those at E and I, may be laid resting upon each other, as in the figure above, in which case the two ridges will be formed as it were into one large ridge; or else the open furrows at E and I may be preserved by keeping the two first furrow-slices at a little distance from each other, and preserving the space between them, thus:

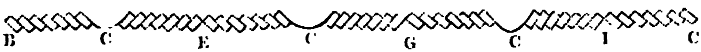
Fig. 97.



When land is ploughed in this manner, the ground is taken from one side of each two adjoining ridges at G, and laid towards the other, E and I, that is, it is gathered towards one side, and gathered from the other. In this manner the ground at the open furrows G, from which we gather, becomes more bare of earth than the open furrow E and I, towards which we gather. This is an imperfection unavoidable in casting a ridge. When, therefore, we wish to cast a ridge twice in succession, we reverse the former mode of ploughing; we gather towards the open furrow G, and from the open furrows E and I, and thus the ridge is restored to its former state.

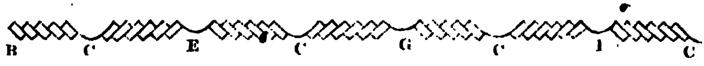
Another method of ploughing is *cleaving*. In this case, the plough commences at the open furrow, lays the first slice towards it, and then returning by the other side of the open furrow, lays the second slice upon the first, as in the following figure. When it has reached the centre, it stops, and begins with another pair of ridges, and ploughs the half of each pair together in the same manner. In this way the open furrows of the ridges become the centres, and the former centres become the open furrows. The operation of cleaving is of constant occurrence in the summer-fallow and other cleaning processes of tillage. When we wish to level a ridge we cleave it.

Fig. 98.



There are two variations to be noted in the practice of cleaving. Either the two first slices are laid close together, in which case the open furrows of the former ridges become the centres, and the former centres the open furrows, in the manner shown in the last figure; or a certain distance is kept between the two first slices, and so the open furrow is preserved. In this case, each ridge is split into two ridges, and the number of open furrows is doubled, thus:

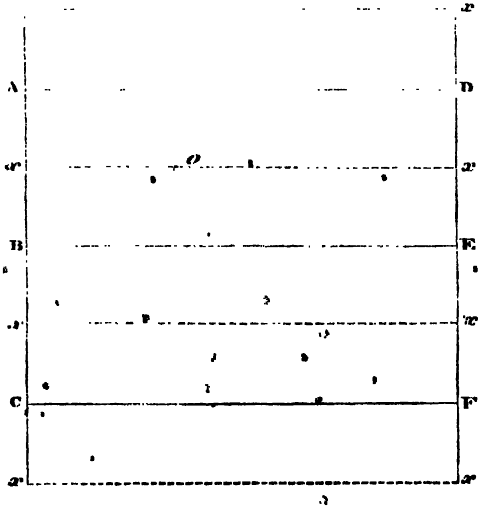
Fig. 99.



The next method of ploughing is *cross-ploughing.* This, as the name denotes, is ploughing in a direction crossing that of the former ridges and furrows.

In cross-ploughing the workmen place themselves at equal distances from one another, as thirty or forty yards, at the side of the field at which they are to begin to plough. Each then runs a straight furrow across the field, as from A to D, from B to E, from C to F. Each then returns as from D to A, from E to B, from F to C, laying always the successive furrow-slices towards the right-hand, until each man arrives at the termination of his allotted space *xx*, *xx*, *xx*, *xx*. There has been thus formed by each workman one great ridge, but so extended that it may be said to be without curvature. The ploughmen, we perceive, turn from left to right around the first furrows AD, BE, CF. But they may also turn from right to left. Thus, in going from B to E, the ploughman lays his first furrow-slice to the right hand. When he arrives at E, he may turn his horses left about, and proceed to D, and returning from D to A, lay his first furrow-slice to the right hand towards DA. Turning left about then at A, he proceeds in the direction BE, and so on, always turning left about until he has

Fig. 100.



arrived at the middle space *o*, when the whole space between AD and BE will have been ploughed.

Sometimes, for convenience and the saving of distance, he may plough in the first place round the central line BE, by turning from left to right, and then plough the remainder of the interval by turning from right to left.

These are matters of detail somewhat difficult perhaps to be described clearly, but so simple in themselves that they need only be seen in the field to be thoroughly understood.

The first operation, we have seen, is striking the furrows previous to forming the ridges. This is done by laying off, by means of furrows, first the lines of the head-lands, and then the parallel lines corresponding to the future centres of the ridges to be formed.

The next operation is forming the ridges. This is done by beginning at the centre, and ploughing towards it till each ridge is formed.

When ridges are formed, they may be subsequently ploughed in different ways.

First, They may be gathered; in which case, beginning at the crown, the ridge is ploughed, and an increased elevation given to it.

Secondly, They may be cast; in which case two ridges are ploughed together, and either formed into one large ridge, or, by keeping the open furrows clear, retained in two ridges.

Thirdly, They may be cloven; in which case, beginning at the open furrows, the half of each adjoining ridge is laid together. The first two furrow-slices may either be laid close together, or the open furrow may be kept clear between them. In the first case, each ridge will have been so cloven as that the open furrow shall have become the crown, and the crown the open furrow. In the second case, each ridge will have been cloven into two, and the number of ridges and open furrows doubled.

In the original laying out of ridges, the lines have been described as running straight through the field; but it is frequently expedient, on account of the inequalities of the surface or other cause, to change the direction of the ridges at some part of the field, so as to facilitate the discharge of water.

The application to this case of the principle of striking the furrows is easy. The ploughman makes a furrow where the change of direction is to take place, straight or curved, as circumstances may require. The one set of ridges terminate at this part, and the other are laid off from it in the new direction to be given. The ploughman, by means of his poles, as before, strikes his first set of furrows, terminating them at the furrow where the change of direction is to take place. From this furrow he strikes his second set of furrows in the direction in which they are to run. The part where the opposite sets of furrows meet may be made an open furrow, or a raised-up ridge or headland, as circumstances may require.

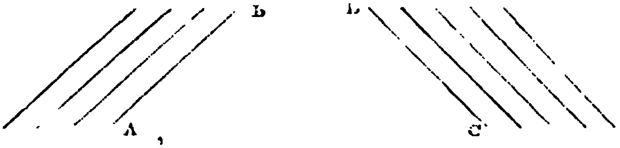
The direction of ridges must generally be regulated by the sloping of the fields, and the lying of ditches and fences, so that they may promote the main purpose for which they are formed, the carrying off of surface water. But, other circumstances being alike, they should be made to lie as much as possible north and south, and as rarely as possible east and west; for, in the latter case, when the ridges are much elevated, the north side has a somewhat less favourable exposure than the south side.

Sometimes ridges are altogether dispensed with, either when the land is very dry, or when it is wished to keep it in grass and give it the aspect of a park or lawn. In this case, the ploughs may either follow one another round the entire field, and terminate at the centre, or they may plough in large divisions, as in the case of cross-ploughing.

In ploughing very steep land, it is frequently laid in ridges diagonally across the slope, for the purpose of rendering the labour more easy, and of lessening the danger of torrents carrying away the surface.

The precaution to be observed in this case, is to make the ridges slope upwards from the right hand, as from A to B in the following figure, and not to the left hand, as from C to D. For in the first case, when the labouring cattle are ascending the steep the plough is throwing the furrow-slice downhill; whereas, in the other case, when the cattle are ascending, they are raising the furrow-slice uphill, by which their labour is greatly increased.

Fig. 101.



Besides the open furrows of the ridges, which act as channels for carrying off the water, it is necessary, where there are hollow places in which water may stagnate, to form open furrows or channels. This is done by drawing a furrow with the plough in the direction most convenient for the purpose. A workman then follows with a spade or shovel, and carefully opens all intersections with other furrows, so that there may be a free communication between them.

Sometimes it is necessary that the furrow made by the plough be further deepened by the spade, so as to form a channel sufficiently large; and wherever headlands intercept the run of water, channels must be cut through them to the ditch or outlet, so that none may stagnate upon the ground. Attention to these details in practice is essential in all cases of tillage; and it manifests a want of all skill and industrious habits in a farmer to suffer his lands to be injured by the stagnating upon it of surface water.

The quantity of land which a plough can go over in an ordinary day's work will, when the instruments are equally good, chiefly depend upon the nature of the soil, and the manner of ploughing.

The common calculation, where good ploughing is practised, is, that a pair of horses will plough an acre when in grass in nine hours. In very stiff soils less will be done; and in very light soils, more. When land is in a loose and pulverized state, from a third to a fourth part more may be done in the time mentioned. In winter, when six hours are generally regarded as a day's work, and at which time the soil is wet, about half an acre in the day may be considered as ordinary work. But taking the year throughout, and soils in all their different states, it may be held that an acre in the day can be done by a man and a pair of horses.*

II. HARROWING.

The next of the simple operations of tillage to be considered is that of harrowing. One man or boy drives a pair of horses and a pair of harrows, though sometimes one person drives three horses and three harrows. The driver walks behind with long reins, which enable him to guide and urge forward the horses; and he must be ready to lift up with his hand or a crooked stick, which he holds for the purpose, the harrows when they are impeded by roots, weeds, or other substances. By lifting up the harrow when in motion, the weeds collected by the teeth fall down.

The harrows pass over the ridge either longitudinally or across. At the end of the ridge they are turned, and generally pass again over the same ground. This is called a double turn of the harrows. When they do not return over the same ground, but pass to another space, they are said to give a single turn. Sometimes a single turn suffices for particular purposes, but more frequently a double turn is required.

Sometimes the harrows give two or more double turns in the same direction, but more generally, after one double turn they give the next double turn across the direction of the previous one, and so on lengthwise and across alternately.

When land is to be pulverized and cleaned of root-weeds, in the manner to be afterwards explained, the operation consists of repeated double turns of the harrows in different directions.

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[*] In some of the very stiff clays of England, as, for example, the London Clay-formation, this calculation will not hold, because the farmers may be often obliged to employ four horses in a team.

The root-weeds being dragged to the surface, are collected by the hand and carried off the ground or burned. The plough prepares the ground for the action of the harrow, and the plough and the harrow acting by turns, the land is ultimately pulverized and cleaned.

Besides the cleaning of the ground, a purpose in harrowing is to cover the seeds of the cultivated plants.

The number of harrowings to be given for this end depends upon the state of the ground and other circumstances When the surface is matted together by the roots of plants, as in the case of land ploughed when in grass, repeated double turns are required to cover the seeds in a proper manner. But when land is already well pulverized, as in the case of summer-fallow, a smaller degree of labour is required. Sometimes two double turns are given, sometimes one, and in some cases, as those when the smaller seeds of grasses are sown, a single turn will suffice.

The operation of harrowing is best performed when the land is dry. Harrowing when the land is wet, is as much as possible to be avoided, both on account of the less efficiency of the operation, and of the injury done to the ground by the treading of the working cattle.

In the case of covering seeds, however, in unfavourable seasons, it is often necessary to harrow the ground when in a wet state. This is one of the accidents which embarrass the farmer, and call for the exercise of his practical knowledge. In extreme cases of this kind, the practice has been sometimes resorted to of attaching several harrows to a beam stretching across the ridge, in the manner before represented (Fig. 18), and of causing the animals of draught to walk in the open furrows.

Harrowing is not a very severe labour for the working-cattle, though more so than from the small weight of the instrument might be inferred. It is the starting and irregular motion of the harrow, and the sinking of the animal's feet in the soft ground, that form the principal labour in drawing. From this latter cause, a light pony or a colt will do more work in proportion to his strength than a heavier horse.

The space of ground that can be passed over by a pair of horses in a summer day's work is generally held to be about twelve acres, so that a pair of harrows will give a double turn to six acres in a day: hence, as a plough will work one acre in a day, the expense of giving a double turn of the harrows is equal to one-sixth part of the expense of giving one ploughing.

III. ACTION OF THE GRUBBER.

The grubber is subsidiary to the plough, and similar in its mode of action to the harrow.

When the purpose is to stir the ground, without turning it over, the grubber may supersede the operation of the plough. It is more frequently used, however, as a substitute for the harrow in the cleaning of land; and it excels the harrow in this, that, having a heavier frame, and being fixed on wheels, it has not the starting and irregular motion of the harrow, and is not subject to be thrown out of the ground when encountered by obstacles.

In using the grubber, the workman walks behind, and when handles are employed, he makes use of them to lift the teeth or coulters out of the ground in turning at the end of the ridges, or when otherwise necessary.

Generally the grubber passes once over the ground to be tilled, but it is frequently found expedient to go twice over the ground. In this case it is proper to set the teeth at half the depth required in the first operation, and in the second to set them at the full depth, and in working the second time to cross at right angles to the direction of the first operation.

The grubber, with two horses, will go over six acres a-day, so that the expense of one operation is equal to one-sixth of that of the plough, or equal to a double turn of the harrows.

IV. ROLLING.

The roller is employed upon the farm in two distinct operations. It is used to assist the harrow in the cleaning of ground, or to smooth and consolidate the surface of land in grass or crop.

When employed to clean land in conjunction with the harrow, the latter is first used, by which the clods, or indurated masses of the soil, are brought to the surface. The roller is then brought to act upon these indurated masses, which it bruises by its weight; and thus it performs, though in a different manner, the same operation of pulverizing the earth which the harrow does. By this mean the harrow is enabled to act upon these clods, upon which its teeth could not otherwise make an impression.

The further use of the roller is the smoothing and compressing of the surface of the ground; and sometimes, in performing this operation, it serves to cover certain seeds, as will be afterwards explained.

In using the roller when the land is in ridges, it is to be driven across the ridges and not longitudinally.

Sometimes one horse is employed in the operation of rolling, but more frequently two. In this case they are generally yoked one in the shafts, and one before, though they could exert a greater force in pulling were they to be yoked abreast. But this is not of any essential importance, two horses yoked in this manner being able to move the heaviest rollers which are employed.

The quantity of land which a roller with a cylinder of five feet can go over in a day is about five acres. By extending the length of the cylinder, a greater quantity of work will be done in appearance though not in reality.

V. DIGGING.

The plough, the harrow, and the roller, are the essential implements of preparatory tillage. To these, however, and the grubber, may be added the spade; which, though properly the instrument of culture in the garden, may be employed occasionally in the fields.

The cases in which the spade may be used in field-culture are those where, from particular causes, the plough cannot be used.

Such is sometimes the case in the first improvement of very steep or rocky ground, where the plough cannot act, or in the case of deep peat, when it is so soft as not to bear the weight of working cattle.

Cultivation by the spade, however, though more efficient, is greatly more expensive than by the plough. It may be sometimes employed with advantage, though rarely on the great scale, where the profit depends upon economy of labour.

The further simple operations of tillage are those performed by the sowing and hoeing machines, and by other implements of the farm. The manner of using these will be from time to time referred to; but it is by practice and observation that the full knowledge is to be obtained. The first object of study of the learner should be the general form of the machines, and the particular purposes for which they are intended. This knowledge being obtained, there is only wanted the opportunity of seeing them employed in the field to understand the manner of using them.

V. PREPARATION OF LAND FOR CROPS.

I. FALLOWING.

The fallowing of land consists of a course of tillage continued for a certain time. When it is continued for an entire season, the process is termed the Summer-fallow.

A course of tillage during only a part of the season is adopted in the case of preparing land for such crops as the turnip, the cabbage, the potato, which are thence frequently termed *fallow-crops*. This preparation consists of a series of ploughings, harrowings, and other operations, continued until the land is cleaned, and otherwise fitted for the crop to be cultivated.

The extension of the culture of fallow-crops has greatly lessened the necessity of the summer-fallow; for the ground receiving a good preparation for this class of crops, and they, from the wide intervals at which they are cultivated, admitting of an efficient tillage during their growth, the farmer is more enabled to dispense with the necessity of devoting an entire year to the tillage of his land.

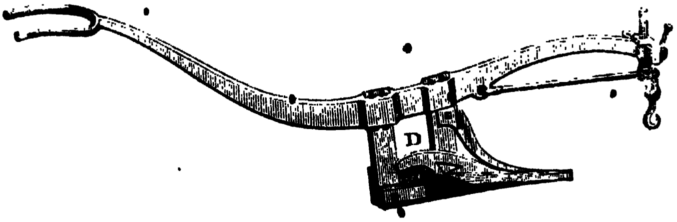
It is chiefly on the stiffer clays that the summer-fallow may be held to be an essential branch of farm management in this country. These are tilled with greater difficulty than the lighter soils, and do not always admit of the cultivation of those particular classes of plants, as the turnip, which are suited to the lighter soils, and which render upon them an entire summer-fallow unnecessary. A further reason exists for the adoption of the summer-fallow on the stiffer clays, namely, that the most valuable of their productions is wheat, for which the summer-fallow affords the best preparation. The manner of performing this process, therefore, merits the serious attention of farmers in this country.

Whatever be the nature of the soil to be fallowed, the first ploughing is in all cases to be given in autumn, or before winter, so that the soil may receive the influence of the winter-frosts, and the growth of weeds be checked: for certain weeds will grow during the months of autumn, and partially in winter and in early spring; but by inverting the surface, and exposing the roots of those plants, and the under part of the sod, to the frost, the vegetation is checked until the process of ploughing can be resumed in the following spring.

In all cases the first ploughing should be as deep as the plough can conveniently be made to go. A good plough with a pair of horses can easily plough from eight to nine inches deep, and this is in most cases an efficient tillage. But, should the nature of the soil render it necessary, an additional force of draught must be employed, so that the requisite depth of furrow may be given. Thus, in some of the marly and tenacious soils of England, four horses may be occasionally required to give sufficient depth to the first ploughing of fallow. Three horses may be also used; these, with a good plough, forming an efficient team, which may be managed by one ploughman.

Often it is beneficial to give a deeper ploughing to land than the ordinary depth of furrow. This may be effected by what is termed trench-ploughing, in which one plough, deprived of its mould-board, follows in the track of another; but, in place of the latter, there has been recently employed a species of plough termed a subsoil-plough. It is constructed wholly of iron, weighs about 4 cwt., and requires the active force of four horses. It has a stout share, but no mould-board. Rising from the share and parallel to the body of the plough, is a flat piece of iron D, the use of which is, that when the plough is struck by stones they may be forced upwards by means of

Fig. 102.



the inclined plane which the piece of iron presents. This is a most efficient instrument, and of admirable use in stirring the subsoil without mixing it with the upper stratum. It is the invention of an ingenious gentleman of Scotland, Mr Smith of Deanstone.

With respect to the manner of laying the ridges, that kind of ploughing must be adopted which is calculated to keep the land dry during the months of winter, this being an essential point of practice in the class of soils for which the summer-fallow is required.

A good method of preserving the land in a dry state is cleaving with open furrows (see Fig. 99). In this manner each ridge is divided into two, so that good provision is made for allowing the free egress of water.

Sometimes the ridges may be gathered (Fig. 95), and at other times, when the land is moderately dry, they may be cast (Fig. 97). In whatever manner the ridges are ploughed, they remain in the same state till the following spring, and care therefore must be taken that all the necessary cross-furrows and channels shall be made and carefully cleaned out, so that no water may stagnate upon the field.

In the ordinary management of the farm, the first operation in spring, as soon as the weather allows, is the sowing of the spring-crops of corn. When this essential labour of the season is completed, which in this country is generally from the middle to the end of April, the tillage of the land intended for such crops as the turnip, the potato, and other fallow-crops, is to be resumed. But though these are the first in the order of preparation, and must necessarily be first attended to, yet the summer-fallow should not be neglected at this early season, but should receive one ploughing not later than the month of May, and the earlier in the month the better.

Now this, the second ploughing of the summer-fallow, may be done in two ways. The land may be either cross-ploughed, or ploughed in the direction of the former ridges. On the lighter and drier soils, in the cases where such soils are subjected to the summer-fallow, the cross-ploughing is the better method. But, in the case of the stiffer clays, the ploughing in the direction of the former ridges is to be preferred ; for this is a provision against the effects of heavy falls of rain, which, were they to occur at this early season, when the land was ploughed, without open furrows to carry off the water, might so saturate it as to render the subsequent tillage precarious and difficult.

The next ploughing, which is to be as early in June as the other labours of the farm will allow, is to be made across. Immediately after this ploughing the land is to be harrowed by repeated double turns, the direction of each double turn crossing that of the previous one. These double turns are to be repeated four, five, or more times, as occasion may require ; and the roots of all plants which are dragged to the surface by the harrows are to be carefully collected by the hand and laid in heaps. A cart then passing along the rows of heaps, the collected plants are to be forked or thrown into it, and carried off the ground. They are to be formed into a compost by being mixed with quick-lime, so as to destroy their vegetative powers.

Sometimes these weeds are burned on the ground, and their ashes spread upon the surface : but this practice is not to be imitated, the ashes yielding an inconsiderable quantity of manure as compared with that which is produced by forming the weeds into a compost.

It is of great importance at this period of the summer-fallow, to drag to the surface and collect as large a portion as possible of the roots of vivacious weeds in the ground ; for, this being the period of active vegetation, every part of these roots which is left in the ground will grow again and extend itself.

It is by the repeated action of the harrows that these roots are detached from the soil and dragged to the surface. When necessary, the roller is also to be employed. This, bruising the clods or indurated masses of earth upon the surface, enables the teeth of the harrow to act upon them. When the roller passes over the ground, the harrows immediately follow.

At this time, too, the grubber may be employed, as subsidiary to the action of the harrow.

This is a period of the summer-fallow at which all obstructions arising from land-fast stones and other impediments to *tillage are to be removed; and if drains are required, it is now* convenient to form them, the stones collected upon the surface being carried forward at once to the drains, and filled into them in the manner to be afterwards explained.

This, indeed, is merely matter of convenience when the stones are in readiness, for the time of summer-fallow is not really the best for the forming of drains, owing to the hazard of heavy rains occurring, and carrying the soil, which is then loose, into the drains. This, however, is but a contingency, and there is convenience in forming such drains as may be needed at this time: and not only at this time, but during all the subsequent operations of the summer-fallow, draining, the removing of obstructions to tillage, and other works, are carried on. The obstructions of this kind to be removed are, generally speaking, any thing that may impede the path of the plough, and interrupt the common operations of tillage,—such are the roots of trees, stones, inequalities of the surface, and the like.

It has been seen, then, that, in the management of the summer-fallow, the first ploughing is to be given before winter, when the land is ploughed lengthwise, in such a manner as that the land shall be kept dry until the tillage can be resumed in the following spring; that the second ploughing is to be given as early as possible in May, and, in the case of stiff soils, lengthwise; and that the third ploughing, which, in the common course of farm-labour, we may hope to accomplish in June, is to be given across, when the principal labour of harrowing, rolling, and disengaging weeds, is performed, and when opportunity is taken to begin to drain, clear the ground of stones, and perform similar operations required.

As soon after the last ploughing and cleaning as the state of the weather and the labours of the farm will allow, the fourth ploughing is to be given. This ploughing may be performed in two ways. It may either be given lengthwise, and the land formed into ridges, or the whole may be ploughed in large divisions, without regarding ridges, as in cross-ploughing.

The former method may be adopted when the season is critical, and the land stiff and naturally wet. This is in order to avoid further hazards from great falls of rain; for, by forming the land into ridges, it is placed in a state of comparative security. But it allows of a better subsequent tillage of the land to lay it flat, by ploughing it in large divisions without yet forming it into ridges.

In this case, the land may be ploughed in a direction at right angles to the previous ploughing, that is, in the direction in which the future ridges are to run; but it will be better to plough somewhat diagonally, that is, nearly in the direction from corner to corner of the field. This is done in order that two successive ploughings may not be in one direction, for the next ploughing to be given, as we shall immediately see, must necessarily be lengthwise in the direction of the ridges. But, by deviating from this direction with the ploughing now to be given, the two successive ploughings will cross each other, and thus the tilling will be better performed.

No sooner is this diagonal ploughing completed, than the process of harrowing, rolling, and cleaning the ground of the roots of vivacious weeds, is to be renewed, precisely as after the preceding ploughing. It is not necessary or expedient that the process of harrowing shall be carried further than is absolutely required to disengage the weeds; but to this extent it is important that it be carried, so that the land may now be cleaned.

These two ploughings, with their corresponding harrowings, are of the utmost importance in the management of the summer-fallow. If the weather has been favourable, the land may now be expected to be effectually cleaned, and thus far to be in good order. Sometimes a further ploughing may be required for the purpose of completing the cleaning process, but whether this be so or not, the land ought now to be formed into ridges. This is necessary, in order to provide against the contingency of heavy rains, which, were they to occur at this period, when the land is lying in a flat state, might so soak it as greatly to retard the future labours.

We now, therefore, proceed to strike the furrows in the manner formerly explained. The land is then ploughed and formed into ridges, and this completes the fifth ploughing which it has received. The land will generally be now ready to have the dung laid upon it. But in some cases it may require a sixth ploughing before it is sufficiently cleaned and prepared for the dung. In this case, the land being harrowed, and the remaining weeds collected as formerly, it is ploughed again in the line of the ridges.

We may proceed, however, upon the supposition, that this further ploughing and cleaning are not required, and that the land, after the fifth ploughing, is ready for the application of the dung. This may bring us, in the ordinary course of farm-labour, to the month of August.

Now, the dung, according to the practice before described, has been previously carried out and laid in large heaps in the field, where it has undergone a certain degree of fermentation. Should this not have taken place sufficiently, the heaps must be turned, so that the dung may be brought to a fit state for use.

The dung is now conveyed to the land in carts from the heaps, the carts being driven along the ridges. It is dragged out from behind by the workman with the dung-drag (Fig. 81) into heaps, as nearly as possible of equal size, and at equal distances, in rows along each ridge. Sometimes, to ensure accuracy, the ridges are divided, by furrows run across them, into rectangular spaces, each space receiving its allotted quantity of dung. But in general the eye and practical knowledge of the workman will enable him to drag out and deposite the heaps in the quantity and with the accuracy that may be required.

Several persons, who may be females or young lads, then spread out the dung all across the ridge, by means of light three-pronged forks (Fig. 74). This operation should be done with much attention, so that the dung may be spread regularly over the ridge.

Close upon the work of the spreaders, the ploughs are to follow and cover the dung. This is done by gathering the ridge, so that, while the ploughing covers the dung, the curvature of the ridge is increased.

The dung being covered in this manner, and the ridge raised, the land is to remain untouched for a few weeks, so that the dung may be decomposed and incorporated with the soil. When the dung has been previously fermented in a proper manner, this incorporation will be completed in a very short time.

The land is now ready to receive what is called the seed-furrow, which is the ploughing given to it previous to the seeds being sown. In this ploughing the ridge is again gathered, but the ploughing being very shallow, it has little effect in raising the ridge higher.

After this final ploughing, and upon the surface now exposed, the seeds, usually of wheat, are to be sown, in the manner to be afterwards described. This generally takes place about the middle of September or later, and completes the important operations of the summer-fallow and sowing of the wheat-seeds.

In this detail the manner of applying the dung has been described: but there is likewise to be considered the manner of applying lime, when this substance is to be laid upon the land in summer-fallow.

There are two periods at which the lime may be applied,—either before the dung is laid on, or afterwards. In the former case, the lime may be laid on just after the land has been formed into ridges, and when it is ready to receive the dung.

The quick-lime, as it is brought from the kilns, may be laid down in heaps of about five carts each, at regular distances, upon the head-lands or where convenient. In this case, it is brought to the farm as opportunity offers, and slacked slowly and regularly.

When we are prepared to spread it upon the ground, a person with a broad-pointed shovel (Fig. 63) is appointed to each heap. He fills his cart, drives it along the ridge, and spreads the lime abroad upon the surface, taking it out with his broad-pointed shovel from the cart behind; sometimes two carts and two men may be appointed for each heap, the one man filling the cart at the heap and the other spreading the lime upon the ridge.

Both men and horses sometimes experience injury from the caustic effects of the lime, especially when the weather is moist. The face of the man may be defended by a thin handkerchief, and the back of the horse should be covered.

When the lime is spread, the land must be immediately harrowed, to incorporate the lime with the soil. This being done, the dung is to be spread upon the ground, and covered by the plough in the manner before described.

But frequently the dung is first spread and the lime is not laid on until just before giving the seed-furrow. This answers very well, provided the land has lain a sufficient time after the dung has been spread, so that it may be decomposed and mixed with the soil.

These details have an especial reference to the stiffer soils, which are those on which the summer-fallow is generally practised. When the lighter soils are to be fallowed, the process of cleaning is more easy, and there is less hazard of serious interruption from the state of the weather. The only variation with regard to the lighter soils that need be referred to, is in the first spring-ploughing. In the case of such soils this ploughing may be given at once across, and the process of harrowing and cleaning then commenced. This is precisely the management pursued in the case of turnips and similar fallow-crops; so that, when the learner comprehends the operations of the summer-fallow thus far, he is acquainted with the manner of preparing the land for an extensive and important class of plants.

In the preceding detail, the ordinary operations of the summer-fallow have been described; but the nature of the seasons, the state of the land, the prevailing weeds to be eradicated, and other circumstances, produce variations in the course of management, which, however, it is not necessary here to point out. They are little subject to rule, but are best determined by the judgment of the farmer, as the cases themselves arise. A more important purpose is served to the student of agriculture by pointing out to him the manner of managing the summer-fallow upon approved principles. Knowing this, a little experience will soon show him how to adopt those variations of practice which the state of the season and other circumstances may render expedient.

The process of the summer-fallow, conducted as it should be, enables us to effect the tillage of clay lands in a manner calculated to eradicate weeds, and fit the land for bearing a lengthened rotation of crops.

After a complete summer-fallow, the land is seen to be in the best order which circumstances will allow. It acquires that mellowness, indicative of fertility, so familiar to the eye of the farmer, yet so difficult to be described. It is frequently observed by farmers, that clay-lands in this climate get into an adhesive, and, as it is termed, a sour state, by the long repetition of crops. The giving them from time to time the mellowing influence of a summer-fallow, during which weeds may be extirpated and the manures applied in the most beneficial manner, is found to have the best effects in restoring the fertility of the soil and fitting it to yield an increased produce in succeeding years. One advantage, too, of the summer-fallow, not to be disregarded, is, that it divides the labour of tilling a farm more regularly throughout the season.

II. LEVELLING GROUND AND REMOVING OBSTRUCTIONS TO TILLAGE.

The most frequent impediments to the common operations of tillage are, swamps, inequalities of the surface, stones, the roots of trees, and the like. The removing of swamps is a branch of draining. *The levelling of ground and the removal* of stones and similar obstructions are to be attended to in the common operations of tillage.

When the surface of ground is unequal, the plough will suffice for levelling it in common cases of tillage. The plough is made to act in this case by repeated cleavings of the land to be levelled. Frequently the surface is previously removed by the spade, so that the soil may be replaced upon the new surface after it has been rendered level.

Sometimes machines are employed for the purpose of levelling ground. The following figure represents a machine of this kind.

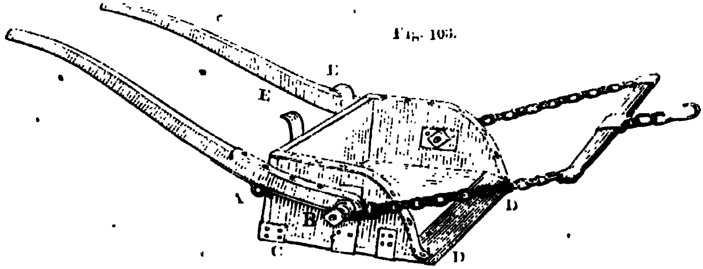


Fig. 103.

It consists of a box in the form of a large shovel, drawn by a pair of horses. There is a short iron pin on each side fixed to the box which passes through a hole or eye in the handle at A. When the handles and pin are in this position, the box is fixed in its place. But by disengaging the handles from the pins, which is done by merely stretching them out a little on each side, the box can turn round upon B as an axle.

The manner of using the machine is this: The workman, holding by the handles, attaches them to the box, and directs the horses forward to the ground to be levelled, or rather an assistant may be employed to lead the horses forward. The workman at the handles in the mean time, by pressing them down, causes the box to move upon the heel C. But when he reaches the ground to be removed, by raising the handles he allows the sharp edge of the box DD to penetrate into the ground: the horses in the mean time moving forward, the box is loaded with earth. By pressing again upon the heel C, this earth can be carried forward as on a sledge to the place where it is to be deposited. When the box arrives at this place, the man at the handles stretches them outwards, and disengaging the handles, allows the box to turn round as in the figure below, and in this manner the load is discharged.

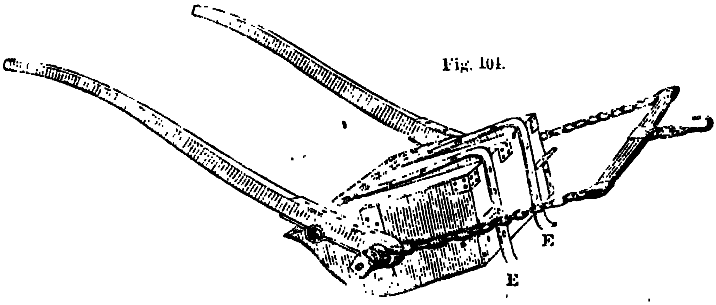


Fig. 101.

The horses in the mean time moving forward, the box is caught on the ground by the projecting points EE, by which means it is again turned round and replaced in its first position. Thus the box carries its load from the elevation to be removed to the hollow to be filled, deposites it, and regains its former position, and this without the necessity of stopping the horses. The machine is efficient and expeditious in its operation. It may be advantageously employed for the levelling of those crooked and elevated ridges which are seen in so many places. But it is to be observed, with respect to the levelling of such ridges, that in all cases the soil should in the first place be removed, so that it may be replaced on the surface, and not buried.

Another obstruction to tillage is the roots of trees. These are generally to be removed by digging round them, lifting them up, and carrying them away. In a country where land is valuable, the slow process of natural decay, which is thought sufficient in newly cleared countries, cannot be waited for.

Another and frequent impediment to tillage is *Stones*. These, when loose and upon the surface, are carried away in carts. *As the cart passes slowly along the ridge*, the stones are *collected and thrown into it, and if drains are being formed* at the time, the stones are taken forward to the trenches to be filled.

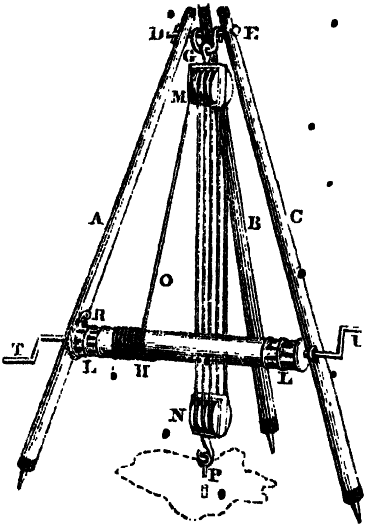
But when the stones are large or land-fast, the removal of them is a work of greater labour.

When they are of such dimensions that they cannot be lifted into a cart they must be broken. This may generally be done by the strokes of a sledge (Fig. 70); and in other cases it may be necessary to blast them with gunpowder. When they are thus broken the fragments are to be removed, and employed for drains and other purposes.

Sometimes the stones are dug under, and a hole formed into which they fall, and in this manner they are buried beneath the reach of the plough. This, however, is a somewhat laborious operation.

In certain cases they are lifted up by machines of different kinds, and hoisted at once into carts. The most efficient of these machines is one formed in the following manner.

A, B, and C, are three strong wooden posts, about 14 feet in length, through the ends of which are holes, for the reception of the strong iron pin DE, upon which is made to slide the curved iron bar G. The holes through which the pin passes being of such a size as to allow a little play to the posts, these may be stretched out like the legs of the common theodolite, in the manner represented in the figure. To the curved iron bar are then attached the fixed block M, and the moveable block N, containing the like number of pulleys. Each of these blocks must be hooped with a strong bar of iron, and the pulleys must be of a size sufficient to admit of a thick rope passing over them. To the lower block N is to be hooked the iron plug P, consisting of a ring for attaching it to the apparatus, of a flat part through which the ring passes, and of a cylindrical part. This cylindrical part may be 2 inches in length, $\frac{7}{8}$ of an inch in diameter at the point, and gradually increasing to about $\frac{1}{16}$ part of an inch more at the neck, where it joins the flat part. The rope O, passing over the fixed pulleys is attached to the windlass H, which is fixed to the posts A and C. At each end of this windlass is a winch, T and U, for the purpose of saving time in tightening the ropes previous to the windlass being worked. To work the windlass there are stout bars or levers, for the reception of which are mortices at L, L, as shown in the figure. At one end of the windlass is fixed a rachet-wheel, with a catch R fixed to the post A, for the purpose of preventing the weight from falling when the moving power is withdrawn. The posts A and C should be connected by a bar, to keep them steady in their place.



The machine thus formed is to be placed over the stone to be raised by extending the posts on each side of it, and then the windlass is to be attached. Of the stone to be thus raised, however large it be, it is enough that the smallest part can be seen. At this part let a workman, with a mallet and the common boring chisel of masons, make a circular hole, about 2 inches deep, and as perpendicular as possible, so that a stroke or two of the hammer may be necessary to drive the pin home. When thus driven an inch more or less into the stone, it is attached to the block, and the ropes are tightened by turning the winch. Nothing more is now necessary but to set the men to work the windlass with the levers; and with no other fastening than this simple pin, stones of some tons' weight may be easily raised from the ground. Being raised up by the pulleys, the stone may be hoisted into a cart or other convenient carriage, and removed from the ground.*

III. PARING AND BURNING.

The process of paring and burning consists in paring off, by means of a spade or plough, the sward or turf of the soil, and burning it, either in heaps, or by setting fire to the turfs on edge, and then spreading the ashes upon the surface.

The process must be performed while the weather is sufficiently dry to allow of the combustion of the turf. It may be begun in the month of April, or, if the weather be dry, earlier, and may be continued throughout the summer as convenience or the state of the weather allows.

The instruments employed in this operation are either a species of spade, pushed along partly by the hands and partly by the pressure of the breast, and thence termed a breast-plough, or by a plough so formed as to cut and lay on its back a thin sward or turf.

The spade or breast-plough is a triangular-shaped spade, about 9 inches in length, and 10 or 12 in breadth. It is fixed to a strong handle, with a cross handle at top, upon which the workman presses with his breast, holding the cross handle at the same time. When he has pushed it forward and under the sod for about two feet or more, he suddenly turns it over, and reverses the sod. He then proceeds as before, pushing and turning over the sod as he advances. Workmen with similar spades follow one another, and thus the whole turf is turned over. The depth of the sod cut is generally from 1½ to 2 inches, or a little more. There is generally a raised edge on one side of the spade, which facilitates the operation.

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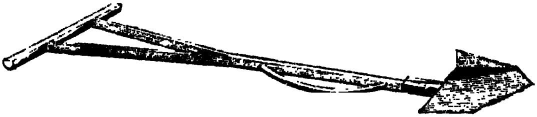
* An account of this curious machine, the invention of Mr **Richardson**, Keswick, and an explanation of the principle on which the iron pin is retained by the stone, though simply driven into it, were given by me in the Edinburgh Philosophical Journal. An account of it was subsequently published in the Transactions of the Highland Society of Scotland. The iron pin, it was shown, is retained in its place by the elasticity of the stone.

Fig. 106.



This instrument performs the work satisfactorily, though it requires considerable manual labour. When the ground, however, is rocky or unequal, it is the best method of effecting the purpose. But in those cases where the land is tolerably level or free from obstacles, as in the fenny districts of England, where paring and burning are practised to a great extent, it is common to substitute a species of plough, formed so as to pare off a thin sod, and reverse it.

The turf being cut an inch or more in thickness, is set up on edge to dry, and after it has remained in this state for a time sufficient to render it dry enough to burn, it is either set on fire as it stands on edge, or it is collected into heaps. The heaps are set on fire and left to burn, being so covered as that they shall burn with a smothered heat. By this slow combustion the whole heap is equally consumed. But there is often difficulty in getting these heaps to burn, in which case it is necessary to employ straw, furze, and other substances, to maintain the combustion.

When the heaps are burned, the ashes are spread abroad upon the surface, and as quickly as possible covered by a shallow ploughing.

Upon the land thus ploughed may be sown a crop of rape or turnips in the same season, to be eaten upon the ground with sheep. This is the best mode of treating land that has undergone the process of paring and burning. Further, the after-management of land so treated should be as gentle as possible; for having called the productive powers of the soil into powerful action, we must be careful not to avail ourselves of this to rob and exhaust it.

Much dispute has arisen on the advantages and evils of paring and burning.

While it is by some contended that it must exhaust the soil of its permanent sources of fertility, by dispelling the soluble matter which it contains, it is contended by others that any loss of soluble matter from this cause is more than compensated by the increased productiveness of the soil, and the consequent means afforded of adding to its fertility by the greater quantity of manures produced, and that, in truth, experience does not prove that the soil is exhausted of its permanent powers of fertility by this process.

But whatever advantages may result from the practice under certain circumstances, it is known that an injurious use is frequently made of the temporary fertility produced; and that, although in many cases it may be an advantageous method of stimulating the productive powers of the soil, there are many others in which this stimulus is too powerful.

The cases in which paring and burning have been found to be always hurtful, are those of a siliceous sand, with a thin covering of sward. A soil of this sort is frequently seen to be reduced to a *caput mortuum* by the operation. In this case, the scanty vegetable matter which such a soil contains being driven off by heat, or exhausted by a few crops of corn, nothing remains but the barren sand of which it was composed.

All thin soils, however, are not thus injured by paring and burning. Thin chalky soils, and indeed the thinnest calcareous soils of any kind, rarely suffer, except under great mismanagement, from paring and burning. The heat probably acts upon the limestone by dispelling the carbonic acid, and this calcareous matter converted into quicklime, produces an immediate action upon vegetation. If such land is gently treated and laid down to grass, it will be covered again with a sward, the growth of which may quickly repair the loss of vegetable matter. Thin chalky downs in England have been subjected to a constant repetition of the process of paring and burning, without any apparent diminution of their fertility.

Again, in deep peaty and fenny soils, the process of paring and burning may be carried on to a certain extent without injury. Here there is a great excess of vegetable matter, and the loss of a part of it at the surface may not be attended with sensible injury. The loss may be more than compensated by the increased produce: and if such lands are laid down to grass, without having been too much exhausted by cropping, the production of fresh sward may soon replace the waste of vegetable matter.

Cold clays, too, have been often much improved by paring and burning. Such soils do not generally contain much vegetable matter, and when that portion of it which is contained in the turf is expelled, a more than corresponding benefit may be derived by improving the texture of the soil itself.

"The process of burning," says Sir HUMPHRY DAVY, "renders the soil less compact, less tenacious and retentive of moisture; and, when properly applied, may convert a matter that was stiff, damp, and, in consequence, cold, into one powdery, dry, and warm: and much more proper as a bed for vegetable life."

"The great objection made by speculative chemists," continues he, "to paring and burning is, that it destroys vegetable and animal matter, or the manure in the soil; but in cases in which the texture of its earthy ingredients is permanently improved, there is more than a compensation for this temporary disadvantage; and in some soils, where there is an excess of inert vegetable matter, the destruction of it must be beneficial; and the carbonaceous matter remaining in the ashes may be more useful to the crop than the vegetable fibre from which it was produced."

"All soils which contain too much dead vegetable fibre, and which consequently lose from one-third to one-half of their weight by incineration, and all such as contain their earthy constituents in an impalpable state of division, *i. e.* the stiff clays and marls, are improved by burning; but in coarse sands, or rich soils containing a just mixture of the earths, and in all cases in which the texture is already sufficiently loose, or the organizable matter sufficiently soluble, the process of torrefaction cannot be useful. All poor siliceous soils must be injured by it."

But even in those cases where paring and burning may be practised, great injury is yet to be dreaded from exhausting by severe cropping the productive powers of the soil thus stimulated. In this manner immense injury may be done, and has been done, and an instrument of beneficial improvement, if discreetly used, converted into a mean of ruining the soil.

When any kind of land is for the first time made arable, a reason may perhaps exist for this method of rendering it as soon as possible productive. But after land has been brought into a state of regular culture, it is difficult to believe, notwithstanding the authority of so many farmers in England, that paring and burning are good as a regular system. Great crops are doubtless raised in the Fens, and other parts, where this system prevails, but greater crops still are raised in the north of England and in Scotland, on inferior soils, and with a less favourable climate, where the system of paring and burning is unknown.

But while paring and burning may be thus injudiciously and too indiscriminately practised, and without the precautions that should attend it, there is no reason why we should not avail ourselves of so powerful an instrument of improvement, when it can be beneficially employed.

The cases in which it may be safely used seem to be—

1st, In the case of poor cold clays, marls, and calcareous soils, when broken up for the first time.

2d, In the case of moors, where there is a considerable stratum of peat, and which are broken up for the first time.

3d, In the case of deep peaty soils, where there is an excess of undecomposed vegetable fibre.

IV. DRAINING.

Principles to be ever kept in mind by the tillage-farmer are to keep his land dry, rich, and clean. The first in the order of these principles, and an essential one to be regarded in cold and humid countries, is to keep the land dry.

While a certain portion of water is essential to vegetation, an excess of it may prove greatly injurious. In the colder countries an excess of water is one of the main causes of infertility, and a primary purpose of the husbandman there is to carry it away from the ground.

The water which falls from the atmosphere does not sink to an indefinite depth, nor generally to a great depth in the earth. It is either retained at or near the surface where it falls, and whence it is evaporated, or it finds its way to a lower level. by channels upon the surface, or in chinks of rocks, or beds of gravel, sand, and other permeable substances beneath the surface.

When water stagnates at or near the surface, or when, having penetrated to pervious substances below the surface, it is finding its way to a lower level, the purpose of the drainer is to confine it to a determinate channel, and carry it away by some convenient outlet, in order that it may not overflow or saturate the soil.

The drains for conveying away water from the surface are: The ditches of fields, which ought to be so laid out as to favour the descent of water,—the open furrows which are formed by the ridges,—and trenches dug in the places necessary for allowing a passage to the water.

The trenches for carrying away surface water, are usually left uncovered, and they are termed open drains. But sometimes they are partly filled with stones or other substances. and then covered with earth, so that while the surface water may sink down and be carried away, the tilling instruments may not be interrupted.

In the forming of open drains, the dimensions must be fixed with relation to the quantity of water to be carried away, and the direction determined by the natural flow of the water, or by the particular course by which it is expedient to conduct it from the ground. In general, open drains are formed in the hollows or lower parts of the land to be drained, so that the water may find access to them from the higher grounds, or sometimes they are formed across the line of descent, in order to intercept the water which runs from the higher grounds to the lower.

In open drains, of whatever depth, the sides should possess a declivity from the top to the bottom, to prevent them from crumbling down and being undermined by the current. Except in the case of rock, this inclination should not be less than 45°; and, when the earth is soft, and the flow of water considerable, it should exceed 45°. In all cases, the earth should be spread from the edge of the trench backwards, so that the water from the land on each side may have access to it.

When drains of this class are covered, they are generally made from 2½ to 3 feet deep, and filled with stones or other loose materials to within a foot of the surface. They are usually in this case carried through hollow places, where the water of the land stagnates, or tends to flow.

The further end to be effected by draining is to form channels for water which has already sunk into the ground, and is either retained by it, or is finding its way beneath the surface from a higher to a lower level. It is the intercepting of water below the surface that constitutes the most difficult part of draining, and which requires the application of principles which it is not necessary to apply in the case of surface draining.

When the soil rests upon a retentive subsoil, the latter may present a surface of resistance to the water; or the water may have sunk down into the subsoil, and be finding its way through channels beneath.

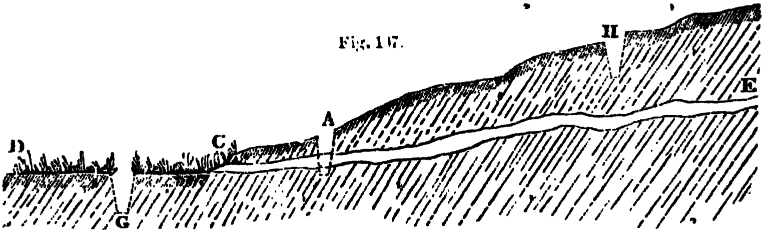
The substances through which water finds its way with facility are the looser earths, sands, and gravels, the crevices of rocks, and beds of loose or decomposing stones: the substances which resist its progress are clays and the harder rocks.

If we shall penetrate a little way into the looser portion of the earth, we shall generally find a series of strata, consisting of gravel, sand, or clay, of different degrees of density. These strata are frequently horizontal, frequently they follow nearly the inclination of the surface, and frequently they are broken and irregular. Sometimes the stratum is very thin, as a few inches in thickness, and sometimes it is several feet thick; and sometimes the traces of stratification disappear, and we find only, to a great depth, a large mass of clay or other homogeneous substance.

When these substances are of a clayey nature, water finds its way through them with difficulty; when they are of a looser texture, water percolates through them freely. These last, accordingly, form natural conduits or channels for the water which is below the surface, when finding its way from a higher to a lower level.

When any bed or stratum of this kind, in which water is percolating, crops out to the surface, the water which it contains will flow out and form a burst or spring, oozing over and saturating the ground, as in the following figure, which represents a section of the ground, from C to D.

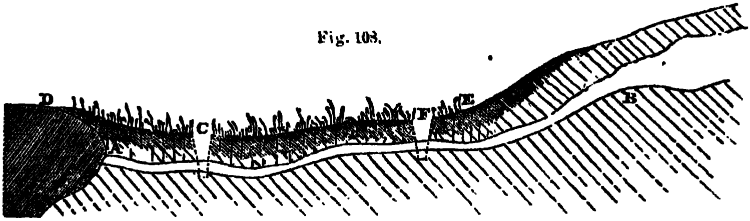
Fig. 107.



When water is, in like manner, percolating through one of these previous strata, and meets any obstruction, as a rock or bed of clay at A, Fig. 108, it is stopped in its progress, and, by the pressure of the water from a higher source, it is forced upwards, and thus saturates the superjacent soil, as from E to D, forming springs, or a general oozing.

In either of these cases, and they are the most frequent that occur in practice, the design of the drainer is to reach the water

Fig. 108.



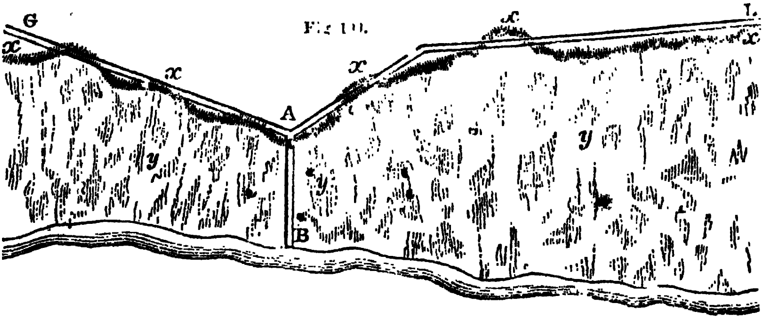
in its subterraneous channel before it shall arrive at the surface, and to carry it away in a drain.

By cutting a drain at A, Fig. 107, the water of the stratum of sand CE, is cut off before it reaches the surface at C, where it forms the swamp CD.

In like manner, in Fig. 108, by forming a drain at C or F, the water is cut off in its channel AB, and thus, in relieving the pressure from the higher source, by giving egress to the water through the drain, the cause of the wetness from E to D is removed.

In looking at the sloping surface of any tract of ground, as a field, in which there is an oozing or bursting out of water, we shall generally distinguish the line where the wetness begins to appear on the surface, extending over a considerable space, *xxxxx*, Fig. 109, the effects appearing in the wetness of the ground farther down the slope, as *yyy*. The line where the wetness begins, and which is generally rendered perceptible by the change of colour of the soil, the tendency to produce subaquatic plants, and other indications of wetness, marks for the

Fig. 109.



most part nearly the course which the line of the drain should follow. By cutting a drain nearly in this line, as from G to A, and from L to A, sufficiently deep to reach the porous stratum in which the water percolates, we shall intercept it before it reaches the surface, and by carrying it away in some convenient outlet, AB, remove the cause of wetness.

This, accordingly forms in the greater number of cases, the rule adopted in practice for the laying out of drains upon the surface. The line is drawn nearly at, or a little above, the line of wetness, or, to use the common expression, between the wet and the dry.

Should the line of drain be drawn too much below the line of wetness, as at G, Fig. 107, then the trench would fail to intercept the water; and further, if it were filled with earth, stones, and other substances, in the way to be afterwards described, the whole, or a part, of the water would pass over it, and the injury be unremoved.

Again, should the line be too much above the line of wetness, as at H, the drain would fail to reach the channel of the water, and so would be useless.

It is for this reason that, in common practice, the rule is, to draw the line of the drain nearly between the wet and the dry, or a little above it, taking care to give it the necessary descent, and to form it of sufficient depth to reach the pervious bed or stratum in which the water is contained.

But as water may arrive at the surface in different ways, and the wetness be produced by different causes, so variations from this rule of lining out the drain may be required, and the judgment of the drainer is to be shown in adapting the course of his drain to the change of circumstances.

Sometimes in a hollow piece of ground, feeders may reach the descent, as in Fig. 110; and the water may be forced upwards by the pressure from each side of the hollow, and thus form the swamp from A to B. It may not be necessary here to cut a trench on each side along the line of wetness at A and B; a single trench C, cut in the hollow, and giving egress to the water, may relieve the pressure and remove the swamp.

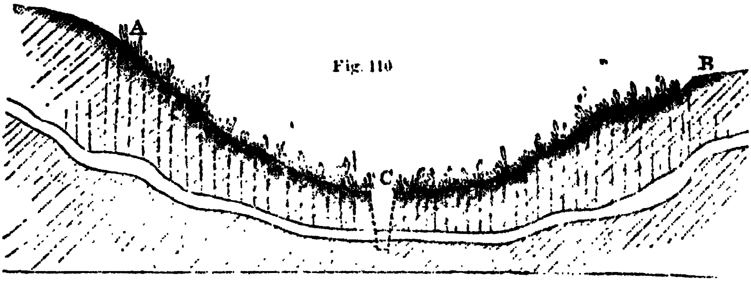
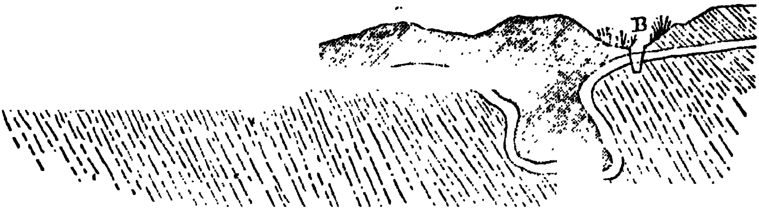


Fig. 110

Sometimes upon a sloping surface, one pervious stratum, in *which* water percolates, may produce more than one line of springs, as at B and A, in the following figure. *Here* a single drain cut at B will remove the cause of wetness at both swamps, without the necessity of the drain at A.

Fig. 111.

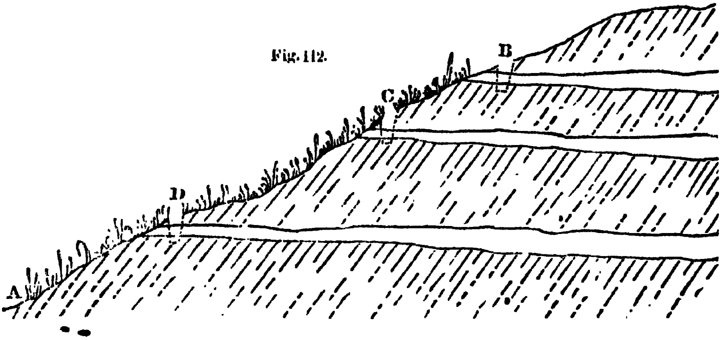


And, in practice, it is well to wait to mark the effects of a drain cut in the higher part of the slope to be drained, for these effects often extend further than might be anticipated, removing springs, bursts, or oozings, at a great distance.

On the other hand, a single swamp, as from B to A, in the following figure, may be produced, and yet one drain at B may be insufficient to remove it. In this case, the water being brought to the surface by more than one channel, it is necessary to form several drains to reach the several beds in which the water is contained, as at B, C, and D.

These examples will show, that one rule, with respect to the laying out of drains, is not applicable to all cases, but that the drainer should adapt his remedy as much as possible to the

Fig. 112.



cause of injury. One end, however, to be aimed at in all cases, is to reach the bed, channel, or reservoir, in which the water is contained.

Before beginning to drain a field or tract of ground, it is frequently well to ascertain, by examination, the nature of the substances to be digged through.

At the upper part where the wet tract to be drained appears, or between the wet and the dry, let a few pits be digged. The place of each pit is to be marked out nearly in the direction of the proposed line of drain, six feet long by three in width, in which space one man, and if required, two, can work. Let the earth be thrown out to the lower side, and to such a distance from the edge of the pit as not to press upon and break down the sides. Let these pits be made to the depth of five or six feet, or more if necessary, so that we may reach, if possible, the porous bed in which the water is contained. Should we find no water, then let us apply a boring-rod, in order to ascertain what depth the porous substance lies in which the water is contained.

Sometimes water will not be found until we come to a great depth. It may be so deep that we cannot reach it by any drain, or even by boring with the auger. In this case a previous examination saves us the labour of making the drain unnecessarily deep. Sometimes we shall proceed to a considerable depth without finding any appearance of water, when, all at once, by breaking through some thin stratum, we shall reach it. The water is frequently seen, in this case, to boil up like a fountain, and this affords the assurance that we shall succeed in our operations.

This species of preparatory examination by means of pits, is therefore, in many cases useful. *It affords the means of judging of the proper depth and dimensions of which the drain shall be formed: it prevents the committing of errors in the laying out of the lines of drains: and it enables the drainer to enter into contracts with his workmen with precision.*

When we have thus, by sinking pits in various parts of our intended lines, obtained an idea of the nature of the ground, of the substances to be digged through, and of the depth of the water, we mark our lines of drains upon the ground.

This may be done by pins, or by a plough drawing a furrow along the intended line.

It is at this time very convenient to make a hand-sketch of the piece of ground to be drained, marking each line as it is laid off in the field, and noting the depth and direction in which the water is to run.

The lines being marked off in the manner described, these are to form the upper edges of the drains.

The width of the drain at the top depends upon its depth, it being usual, except in the case of very hard and tenacious substances, to make it slope from the top to the bottom. Thus, if it be 6 feet deep, and from 18 inches to 2 feet wide at bottom, it may be 2½ feet wide at top.

The workman, in forming the trench, works up to the higher ground, and never from the higher ground to the lower. The instruments which he uses in the operation are—the common spade, Fig. 62, a shovel for throwing out loose substances, Fig. 64, a pick or mattock, Fig. 65, for raising stones, and breaking the earth when hard, and the foot-pick, Fig. 67.

The materials to be used for filling the drain may be stones, tiles, or other hard and durable substances. When stones are to be employed, if they are inconveniently large, they may be broken to the weight of three or four lb. They may be laid down for use, before the cutting of the drain is begun, along the upper line of the drain, the earth being thrown by the workmen to the lower side ; or else they may be brought forward while the work is going on, and thrown from the cart into the drain.

In the larger class of drains it is regarded as beneficial, and even necessary, to form a conduit at the bottom. This is done by building a little wall roughly on each side at the bottom, about 6 inches in height, and so as to leave an aperture or conduit of about 6 inches in width. The workman then covers it with such flat stones as he can procure, filling up also the interstices of these covers with smaller stones, so as to defend the conduit from earth and other substances that might fall into it. When this is done, the remaining stones are thrown in promiscuously to the height of 18 inches or 2 feet above the cover. The stones are then to be made level at the top, and either covered with the sod which, on breaking the ground of the drain, had been laid aside for that purpose, or with a covering of straw, heath, or the like. This covering is to prevent the loose earth from falling amongst the stones.

When these operations are completed, the earth which had been thrown out of the trench is shovelled upon the stones until it be above the level of the surface. The purpose of raising it higher than the surface is to provide for the subsidence of the loose earth, which is generally found to be rendered more compact, and to occupy a smaller space than it did in its original state. When a portion of the earth is shovelled in, it is an economy of labour to employ a common plough for filling in the remainder.

A drain thus formed will appear on a transverse section, as in Fig. 113, and after the subsidence of the earth as in Fig. 114. Where the soil is very soft, it is of benefit to pave the lower part of the drain with stones or slates. In the whole operation of forming the trench and conduit, great care is necessary in seeing that all the parts of the work are executed well.

Fig. 113.

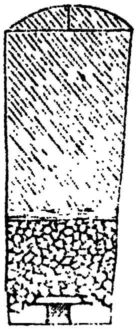
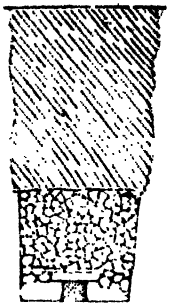
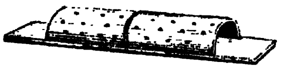


Fig. 114.



The stones used for this species of drain may be sandstone, or any of the harder stones that can be obtained. But, in many cases, stones are not to be obtained, in which case tiles may be subtituted.

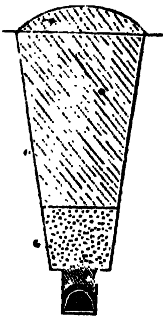
Fig. 115.



The tiles, which are made with an arch as in the annexed figure, may be formed of separate pieces of about 14 inches in length. Flat soles are made of the same material, on which the arched tiles are to rest.

The method of forming the drain when tiles are the material employed, may be somewhat different from that adopted when stones are used.

Fig. 116.



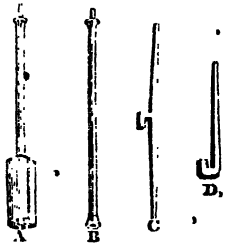
The drain is carried down as narrow as a man can work, and at the bottom an excavation is made by means of a narrow-mouthed spade, to fit the dimensions of the tile, which is then placed upon its stand or sole. Above this should be laid some loose materials, as clean gravel or sand, for allowing the filtration of the water. Even brushwood, and such materials, may be used; for, though they are not of great durability, they serve the purpose, even after they have decayed, of rendering the earth more open and pervious to water.

Drains formed in this manner, whether the material employed be stone or tile, will be found efficient when they are laid out in the proper direction, and when the pervious substances are reached in which the water is contained.

But it is often impracticable to reach these substances with a drain of common depth. In this case, apertures may be formed at the bottom of the drain, by boring or sinking down at the proper distances, until the pervious beds in which the water is contained are reached. By this mean the water will be allowed to flow up from below into the cavity of the drain, and so will be carried away.

The application of this principle had been familiar from early times in the sinking of wells. But it was not till after the middle of the last century that the same principle was applied to the draining of land. This was done by Mr Elkington of Warwickshire, who employed the auger and the boring-rod for the purpose of reaching the channels and reservoirs below the surface, when an ordinary drain could not reach them.

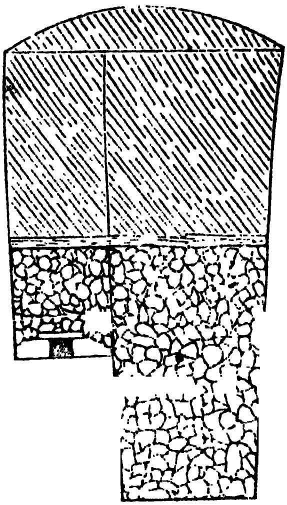
Fig. 117.



The auger employed for this purpose is similar to a carpenter's wimble. It may be from 4 to 5 inches in diameter. Square iron rods are made to be screwed into one another, so that the length of the line of rods may be increased in proportion as the auger penetrates the ground. In the annexed figure, A is the auger, B one of the rods, C a key for turning it round and working it, D another key for holding the rods when they are to be unscrewed by means of the key C.

This instrument may be sometimes found useful when the channels and reservoirs of water can be reached in this manner. The apertures are formed by the auger in the bottom of the drain. When the water is reached, it will spring up into the drain, in the same manner as water in the bottom of a well. It is not necessary to employ any artificial means for keeping the apertures open, as the flow of the water will suffice to maintain for itself a passage.

Fig. 118.



Sometimes, in place of an auger-hole, wells are sunk at intervals along the side of the drain, and filled with stones in the manner shown in the figure.

In all cases of draining where the water to be reached is at some depth, the drains should be made of sufficient dimensions. They should not be less than 4 feet deep, even when the pervious strata lie at less depth; and the reason is, that they may be more permanent, and better defended from injury from mud and sand carried down by surface water. It is not necessary that they be made deeper than 4 feet when that is found to be sufficient; but they must be carried, if necessary, to the depth of 6 feet, or even sometimes of 7 feet, though the expense and difficulty of executing the work increase, in a great proportion, as the dimensions of the drain increase.

The importance, in this species of draining, of proceeding upon principles in laying out the lines of drains, instead of acting at random, as so many do, cannot be too strongly impressed upon the attention of the drainer. Every drain, however rudely devised, and imperfectly executed, may do some good. But one drain well laid out, and of the required dimensions, may perform a purpose which no multiplication of minor and insufficient drains can effect. These may lessen the effects of wetness, but the other is designed to remove the causes of it; and the more perfect practice will usually be found in the end to be the most economical as well as the most efficient.

The drains of the larger class described, it will be seen, are intended for the removal of water which is contained in reservoirs and channels below the surface.

But frequently the water to be intercepted is very near the surface, as between the soil and subsoil, or the subsoil is so homogeneous to a great depth, that no pervious strata can be readily reached. In such cases, the drains may be of smaller dimensions, and increased in number, so as to afford many outlets to the water with which the soil and subsoil are charged.

A system of draining, having relation to this condition of the soil and subsoil, has been termed the Essex system, from its having been extensively practised in that flat and clayey district, and it is now very generally termed *furrow-draining*. The system consists in forming a series of small drains parallel to one another, in the open furrows between the ridges. In this species of draining, the design is not to reach the water as it percolates in pervious channels beneath the surface, but to afford numerous outlets to the water which the soil and subsoil retain. The system is for the most part greatly more expensive than the other: yet as it is efficient, is easily practised, and produces an immediate effect in drying the ground, it is often preferred even where the purpose might be otherwise effected. It may often, however, be combined with the system of deeper drains; the latter being employed to intercept the springs and larger body of water, and the former to give an increased degree of dryness to the surface.

The materials that may be employed in this species of draining are tiles or stones, the latter being broken to the size of small road-metal. Of these materials, tiles are held to be the most convenient and economical, from their requiring a smaller trench, and from their being more easily carried, and more readily taken up and replaced when injured. They are formed into an arch of a semi-elliptical form, and they are made to rest on flat soles in the manner shown in the figure 115. The size of the arch varies with circumstances: the usual size is from 3 to 4 inches wide within, and from 4 to 5 inches high, and the length of each tile is about 14 inches. The soles are flat, or slightly curved, and made to project about a quarter of an inch on each side of the tiles. These are the usual dimensions for the smaller parallel drains; but where main drains are formed to receive the water from the smaller drains, the size of the tiles is increased to 7 or 8 inches wide within, with a corresponding height.

The principle adopted in laying out this class of drains, is to form one or more main or receiving drains across the ground to be drained, and to conduct into these the minor drains which follow the course of the ridges. The receiving drains are formed of greater size, by employing the larger form of tiles, or by placing two tiles side by side, and sometimes with their edges together, so as to combine the two arches into one tube; and sometimes three or four tiles are employed variously arranged. The minor drains lead to these receiving ones, and the water is permitted to enter by chipping off corners of the larger tiles, at the places where the tiles of the smaller drains terminate. It is better, however, that sets of tiles be prepared at the tile-work, in which case the apertures can be made either through the sides of the tiles, or at the corners.

The depth of the drains should be sufficient to place the tiles completely beyond the reach of injury from the deepest ploughing. A medium depth of the smaller drains is from 18 to 24 inches. They are formed by first taking up a spit with the common spade, and then employing the narrower spade, shown in figure 119, so as to form the trench with a slope to the bottom, where the width should be just sufficient to receive the soles of the tiles; and in order to clear out any mud or loose earth in the trench, there is employed the species of shovel, Fig. 120. Sometimes, in order to save some expense in digging, the earth at the surface is first removed by the plough, which passes along without the mould-board, and then returns by the same track, with the mould-board attached, so as to push the earth to a side and form a furrow. In proportion as the trenches are formed by one set of workmen, the tiles are laid

Fig. 119.

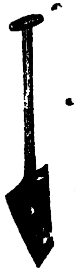


Fig. 120.

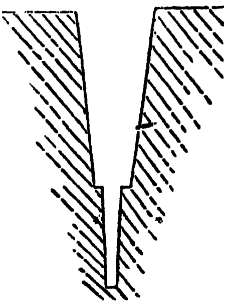
by another. The workman in laying the tiles works backwards, the tiles having been previously laid along the line of the drains, and there is usually an assistant to hand them to the person in the trench. This part of the operation must be performed with care, so that the soles shall be placed firmly and evenly on their bed ; and so that the acclivity shall be always sufficient to cause the water to run. The earth is shovelled back upon the tiles, and care should always be taken that the looser soil of the surface be laid next the tiles, so that the space above them may be rendered as pervious as possible to water. When there is any sod upon the surface at the time of draining, this should be laid aside, and placed upon the tiles with the grassy side below, and then the looser soil next the surface is to be shovelled in, and lastly the more tenacious subsoil. And it is even an improvement in this kind of drains to lay over the tiles some gravel, sand, peat, or other pervious matter, before replacing the earth. This species of draining is of admirable use in drying the soil, by affording outlets to the water with which it may be charged, but care should be taken not to apply the principle to cases to which it is unsuited. It is plain that the method is not well adapted to the removal of springs and swamps produced by water beneath the surface. It may indeed keep the stratum of soil comparatively dry, even when the wetness is produced by the rising of water from beneath, but then it is a very inartificial method of producing the effect, since the water may be far more effectually removed by intercepting it by a drain along the line of the descent, in the manner before explained.

This kind of draining is mainly to be recommended for its efficiency, and for its speedy action in rendering the soil dry. When the tiles are good, and laid with care, these drains will last for a long period. When choked at any particular part, they can be easily taken up at that part, and the tiles replaced, or new ones substituted.

Thorns, brushwood, and branches, are frequently employed in the filling of drains. They serve the purpose of affording a more pervious channel to water, but they soon decay, and the drains are very apt to be choked. Sometimes, indeed, the channels formed by the water remain, when there is a considerable current, long after these materials have decayed. But this cannot be depended upon, and such materials, therefore, ought not to be used if better can be obtained.

Sometimes a species of draining, termed Wedge-draining, has been employed. The general method of performing this is to form a narrow trench with a long narrow shovel. The spit being taken out as deep as the shovel can go, a scoop is employed to clear out the mud and loose earth at the bottom. Then another spade narrower than the first is used, and a second spit taken out, and lastly a corresponding shovel to clear the whole out,—forming a trench with a ledge as in Fig. 121.

Fig. 121.



A piece of sod, with the grass side below, is then forced down, and resting upon the ledge, a space is left for the water below. Sometimes the ledge is dispensed with, and the sod is merely formed into a wedge, narrowed towards the grassy side, and this, when the little trench is cleared out, is pressed into it and covered with earth; and as it does not reach the narrow bottom, a channel remains below, through which the water percolates.

This simple species of drain has been extensively adopted in some districts; and as it is easily formed, and as the number of drains may be multiplied at little expense, considerable benefit has resulted from the use of it. But although drains of this kind will sometimes remain open for a considerable time, they are exceedingly apt to be closed up; on which account, the use of tile is in most cases to be preferred.

VI. SUCCESSION OF CROPS.

All plants which are cultivated, and which are carried from the ground where they are produced, tend to render the soil less productive, or, in the language of farmers, to exhaust it.

But plants which are suffered to decay, or which are consumed by animals on the ground on which they grow, do not exhaust the soil. On the contrary, the decay of the stems and leaves of such plants, either naturally, or by the consuming of them by animals, tends to add those decomposing organic matters to the soil which form one of the elements of its fertility. This process may be imperceptible and slow, but it is that which Nature herself employs to form the soil, as distinguished from what has been termed the subsoil.

Sometimes this process of decay is counteracted by the singular natural provision, of a conversion of the decomposing vegetables into a substance which itself resists decomposition —peat. But, with this exception, the tendency of the decay of vegetables upon the surface is to add to the fertile matters of the soil.

This is well understood in the practice of agriculturists. When the productive powers of a soil have been exhausted by cultivation and the carrying away of its produce from the surface, it is laid down to herbage, in which state the future vegetation which it produces tends, by its decomposition upon the surface, to renovate the productive powers of the soil. Land in this state is said to rest.

When land, however, has been empoverished by successive crops, and has become full of weeds, the laying it down to rest in that state is attended with less beneficial consequences than when the soil has been previously cleaned of injurious weeds, and fertilized by good culture. In the former case, the process of renovation is slow, if perceptible at all; the useless plants increase, and not those which are beneficial and afford food to pasturing animals. Land, when properly laid down to grass, therefore, tends to recover its wasted powers of production. Land not properly laid down has less of this healing property, and may be more full of weeds, and no richer when ploughed up again after a time, than when first laid down. Under good management, however, the laying down of cultivated land to grass and other herbage-plants to be consumed upon the ground, is a mean of resting the soil, and renovating its powers of production; and this mode of *recruiting an exhausted soil* being always at the command of the farmer, its application is important in practice. It is to be observed also, that the poorer soils require this species of rest and renovation more than those which are naturally productive.

The experience of husbandmen from the earliest times has shown, that the same kinds of plants cannot be advantageously cultivated in continued succession. The same or similar species tend to grow feebly, or degenerate, or become more subject to diseases, when cultivated successively upon the same ground. Different causes have been assigned by physiologists for this degeneration; but whatever opinion may be formed regarding the causes, it is from the observed fact that has resulted the rule which forms the basis of a system of regular alternation of crops, namely, that plants of the same or similar species shall not be cultivated in immediate succession; and further, the same rule has been thus far extended, that the same species shall recur at as distant intervals of the course as circumstances will allow.

All herbaceous plants whose produce is carried off the ground which yields them, may be said to exhaust the soil upon which they grow. But all such plants do not exhaust the soil in the same degree; for after some species the soil is seen to be more impoverished than after others.

And not only do different species of plants exhaust the soil in a greater or less degree than others, but the same species does so according to the different period of its growth at which the plant is removed from the ground.

When a herbaceous plant is suffered to grow until it has matured its seeds, it exhausts the soil more than when it is removed before its seeds are matured. All herbaceous plants, therefore, when cut in their green state, that is, before they have matured their seeds, exhaust the soil less than when they remain until they have ripened their seeds. Thus the turnip, when used in its green state, is one of the least exhausting in the agricultural class of plants to which it belongs; but the turnip, when allowed to remain upon the ground until it has ripened its seeds, is one of the most exhausting plants that is cultivated amongst us; and so it is with the rape and others.

Further, certain plants, by the larger or smaller quantity of manure which the consumption of them affords, are more or less useful in maintaining the fertility of the farm.

When a herbaceous plant is suffered to mature its seeds, and when any part of these seeds is carried off the farm, the plant affords, when consumed by animals, a smaller return of manure to the farm than if the same plant had been cut down before it had matured its seeds, and been in that state consumed by animals. Thus it is with the turnip plant referred to. This plant is with us sown before midsummer. In the first season it forms a napiform root, and puts forth a large system of leaves. Early in the following season it puts forth a long stem, which bears flowers, and the seeds are generally matured about midsummer. If this plant is removed in the first stage of its growth, that is, after it has put forth its large leaves and formed its root, and is then consumed by animals, it returns a great quantity of manure; but if it remains until the second state of its growth, then the consumption of its roots and leaves returns scarce any manure. The juices of the root have apparently been exhausted in affording nutrition to the flower-stem, the flowers, and the seeds.

It is beyond a question, that, in order to bring a plant to its entire maturity, by the perfecting of its seeds, a larger quantity of the nutrient matter of the soil is sucked up by it than when it is brought only to its less advanced stages. When crops of plants, therefore, are suffered to arrive at maturity, they are greatly more exhausters of the soil on which they grow than when they are cut down while they are green; and if those seeds are in whole or in part carried off the farm, the crops are exhausters of the farm, as well as of the ground which had produced them. Were the ripened seeds to be wholly returned to the soil, it may be believed that they would give back to it all the nutrient matter which had been derived from it. But, in practice, seeds are employed for many purposes, and are generally carried off the farm which produces them. When this is done in whole or in part, the plants produced are in an eminent degree exhausters of the farm, as well as of the soil on which they have grown.

Further, certain plants, from their mode of growth and cultivation, are more favourable to the growth of weeds than other plants. The cereal grasses, from growing closely together, and not admitting, or admitting partially, the eradication of weeds, are more favourable to the growth and multiplication of weeds than such plants as the turnip and the potato, which are grown at a considerable distance from one another, and admit of tillage during their growth, and whose broad leaves tend to repress the growth of stranger plants.

Having these principles in view, certain rules may be deduced from them, for the order in which the crops of plants in cultivation in a country shall succeed one another on the same ground.

1*st*, Crops consisting of plants of the same or similar species, shall not follow in succession, but shall return at as distant intervals as the case will allow.

2*d*, Crops consisting of plants whose mode of growth or cultivation tends to the production of weeds, shall not follow in succession.

3*d*, Crops whose culture admits of the destruction of weeds shall be cultivated when we cultivate plants which favour the production of weeds. And further, crops whose consumption returns to the soil a sufficient quantity of manure, shall be cultivated at intervals sufficient to maintain or increase the fertility of the farm.

And, 4*th*, when land is to be laid to grass, this shall be done when the soil is fertile and clean.

These rules may be applied to the plants which form the subject of common cultivation in the fields. In this country, the plants chiefly cultivated on the large scale are,—the cereal grasses, chiefly for the farina of their seeds; certain leguminous plants, as the bean and the pea; plants cultivated for their fibres as the flax and hemp; for their leaves, roots, or tubers, as the turnip, the cabbage, and the potato; and certain leguminous and other plants for forage or herbage. The plants of these different classes are yet to be described; and they are now only referred to with relation to the order in which they may succeed one another.

1*st*, One class of these plants consists of the cereal grasses. These are chiefly wheat, barley, oats, and partially rye. All these plants are in an eminent degree exhausters of the farm. They are all suffered to mature their seeds, and are wholly or partially carried away from the farm. Further, from the manner of their growth and mode of cultivation, they all tend to favour the production of weeds. For these reasons, and on the general principle that plants of the same or similar kinds should not follow in succession, the cereal grasses should not succeed one another, but should be preceded or followed by some crop, which either exhausts the soil less, or admits of a more perfect eradication of weeds.

2*d*. The leguminous plants cultivated for their seeds, as the bean and the pea, are all exhausters of the soil. They ripen their seeds, and these seeds are for the most part carried off the farm. Some have supposed that they are less exhausters of the soil than the cereal grasses. But the essential difference between them, when considered with relation to their effect upon the soil, is, that, from their growth, and the manner of cultivating them, they are greatly less favourable to the production of weeds than the cereal grasses. By their broader system of leaves, they tend to stifle the growth of weeds more than the cereal grasses: and further, they admit of tillage during a great part of their growth. This is especially the case with the bean, which is therefore regarded as a useful cleaning crop, and so is cultivated in rotation with the cereal grasses, as a mean of preserving the land clean.

3*d*, Hemp and flax, which are cultivated chiefly for their fibres, and all plants cultivated for their oils, are exhausters of the soil. They are suffered to form and ripen their seeds, and their stems afford no return of manure to the farm.

The next class of plants, from the large returns of manures which the consumption of them affords, may be regarded as enriching or restorative crops, in contradistinction to the others, which may be termed exhausting crops:—

1. The turnip, the rape, and other plants of the cabbage genus, cultivated for their roots and leaves, and consumed upon the farm.

2. The potato, the carrot, the parsnip, the beet, and other plants cultivated for their tubers and roots, and consumed upon the farm.

3. The leguminous plants,—the clover, the tare, the lucerne, and others,—when cut green for forage, and consumed upon the farm.

The plants of the latter class, namely the leguminous, when mixed with gramineous plants, as the rye-grass, are commonly termed the artificial grasses, but would be more correctly termed the cultivated herbage or forage plants. They are often suffered partially to ripen their seeds, and are made into hay; and in this case they follow the general law, exhausting the soil more than when used green. And when the hay crop is carried away from the farm, they are to be regarded as exhausting rather than restorative crops.

In speaking of these different classes of plants, the following terms may be employed:—

1. The cereal grasses may be termed Corn-crops.

2. The leguminous plants cultivated for their seeds, Pulse-crops.

3. The turnip, and other plants of the same kind, cultivated

for their roots and leaves, may, with reference to the mode of consuming them, be termed Green crops; or, with reference to the manner of preparing the ground for them, Fallow-crops.

4. The potato and plants of other families cultivated for their roots and tubers, may, in like manner, be termed Green or Fallow crops.

5. The leguminous plants cultivated for green food, as the lucerne and tare, may be termed Green Forage crops.

And, lastly, the mixture of gramineous and leguminous plants cultivated for herbage or green food, may, in compliance with common language, be still termed the Sown or Artificial Grasses.

Further, distinguishing these different classes of crops according to their effects upon the fertility of the farm, they might be divided thus:—

1. Corn-crops,—exhausting crops, and favourers of weeds.

2. Pulse-crops,—exhausting, but cleaning crops, or capable of being rendered so.

3. Green or fallow-crops,—restorative, and cleaning crops.

4. Green forage-crops,—restorative, and sometimes cleaning crops.

5. The sown grasses,—restorative crops.*

Knowing these, the general characters of the cultivated plants, we have, in devising a rotation, to cause the restorative and cleaning crops so to alternate with the exhausting crops, as that the land may be preserved fertile and clean. Further, when we find that land cannot be sufficiently cleaned by means of cleaning crops, we must make use of the summer fallow; and again, when we find that land requires rest, we may lay it down to grass for a longer or shorter time, taking care when this is done, that the land shall be in as fertile a state as circumstances will allow, and free of weeds.

The application of these principles will be best explained by adverting to some of those courses of crops which have been found good in practice, both as maintaining or increasing the fertility of the soil, and as admitting of an economical division of labour upon a farm.

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* Memoir by me on the Lease.—Quarterly Journal of Agriculture.

The first of these courses is the four years' course, or four-shift course, as it is sometimes called. This course is of very general application, and forms the basis of nearly all the most approved rotations on the lighter soils and inferior clays of this country. It consists of a regular alternation of the following crops:

1st year,	Turnips or other green crop, manured.
2d,	Corn-crop, as wheat, barley, or oats.
3d,	Sown grasses.
4th,	Corn-crop.

In this course, we observe that each exhausting crop alternates with a restorative one; and that, in each year, one-half of the farm is under exhausting, and one-half under restorative, crops.

This rotation is adapted to a large class of soils fit for carrying green crops, though these soils ought to be rather of the better class, in order to admit of a continuance of this course in cases where there does not exist a supply of extraneous manures. When the whole produce of the restorative crops, namely, the green crop and cultivated grasses, and the straw of the corn-crops, are consumed upon the farm, the fertility of the soil will be generally maintained under this course. But when these are partially carried away, a supply of extraneous manures is necessary, otherwise the soil will decrease in fertility, and the course become what is termed a scourging one. This course, although an admirable one for an extensive class of soils, has this defect, that the crops of the same kind return at too frequent intervals, and hence are apt to fall off in quality and productiveness. Under a long continuance of this course, the red clover can often scarcely be made to grow. The land is said to *tire* of the crop, and the expression and the fact illustrate the general principle before referred to, that plants of the same species should not return at too short intervals.

The four years' course, however, with the defects that attend it, is of very general application. It was derived from Norfolk, and is frequently termed the Norfolk-course, and it is, in a great measure, from its general adoption that the husbandry of that country has become so celebrated.

The summer fallow may be substituted for the manured green crop in the first year of this course, and then the course becomes:—

1st year, Summer-fallow;
2d Corn-crop;
3d Sown grasses:
4th Corn-crop.

The course, thus modified, is adapted to the stiff and humid clays, where turnips and other green crops cannot be profitably raised. The course is defective in this, that the summer-fallow is too frequently repeated; and it has the same defect as the Norfolk-course, as to the frequent return of the cultivated red clover.

Other rotations, founded upon these, are produced simply by prolonging the period for which the land sown with grass-seeds shall remain in grass. When the course is intended to be for five years, the land remains two years in grass thus:—

1st year, Summer-fallow, or green crop manured;
2d Corn-crop;
3d Sown grasses;
4th Grass for pasture;
5th Corn-crop, generally oats.

This excellent course is less severe than the four years' course, and, requiring less manure to maintain or increase the fertility of the soil, it is better adapted to all soils of inferior quality. It does not yield so great a gross produce as the four years' course, and therefore, where the soil, or the command of manures, admits of the latter, there is not any reason why it should not be preferred. But in other and dissimilar cases, the five-years' course, as this is frequently termed, will be found to be preferable. Wherever, in this course, the soil is suited to the production of green crops, the first crop of the series should be of that kind. But when the land is not suited to the pro-

[illegible] of green crops, or when, from any cause, the summer-fallow is to be preferred, then the summer-fallow may supersede the green crop in the first year of the series.

Although the five-years' course, which allows the land to remain two years in grass, is suited to soils pretty low in the scale of fertility, yet it is often necessary, when the soil is poor or exhausted by previous cropping, to allow it a longer rest; in which case, the land, instead of two, remains three or more years in grass.

The four and the five years' courses are suited, it has been said, to a great extent of land in this country. But the richer clays, as well as the lighter loams of the better class, admit of a more extended and varied range of cultivation; the particular plants to be produced being determined by demand for the produce, peculiarity of local situation, command of extraneous manures, and the like.

When this is the case, it is easy to extend the four-years' course in a manner to comprehend the further plants to be produced. Let it be supposed that the land is of the richer clays, and that it is suited to the summer-fallow, then the course may be:—

1st year, Summer-fallow, manured;
2d Wheat;
3d Sown grasses, generally for hay or green forage;
4th Oats;
5th Beans, manured;
6th Barley or wheat.

This is a course deserving of imitation in all the cases suited to it, that is, where the soil is sufficiently clayey and rich, and does not require rest in pasture. Under this course, it will be seen that two-thirds of the farm are under exhausting crops, and one-third in summer fallow and restorative crop.

A slight deviation can be made on this course without altering the principle of it, namely—

1st year, Summer-fallow, manured;
2d Wheat;
3d Beans;

4th year, Barley or wheat;
5th Sown grasses, generally for hay or green forage.
6th Oats.

But we can render this course less severe, by allowing the land in grass to remain two years in that state, when the course becomes—

1st year, Fallow:
2d Wheat;
3d Sown grasses;
4th Grass;
5th Oats;
6th Beans;
7th Barley or wheat.

In which case we have three-sevenths in restorative crops, and four-sevenths in exhausting crops. It is therefore more severe than the four years' course, in which two-fourths are in exhausting crops. When the soil is light and fertile, as a sandy or gravelly loam, the summer-fallow of the last-mentioned courses may be dispensed with, and any kind of green crop substituted:—

1st year, Green crop, as turnips, potatoes, beet, or the like, manured;
2d Wheat or barley;
3d Sown grasses;
4th Oats;
5th Pease or beans, manured;
6th Barley or wheat.

Under this course, as before, two-thirds are exhausting crops, and one-third restorative crops. The course requires a good soil. It may be rendered less severe, by allowing the land to remain two years in grass, in which case the course becomes—

1st year, Green crop, manured;
2d Wheat or barley;
3d Sown grasses, for green forage or hay;
4th Grass for pasture;
5th Oats;
6th Beans or pease, manured;
7th Barley or wheat;

In this case we have three-sevenths in restorative crops, and four-sevenths in exhausting crops, in which respect it appears inferior to the four years' course; but it is superior to it in this, that the crops are more varied, and if we shall make wheat only once in the rotation, it will fulfil in an eminent degree this condition, that two crops of the same species shall return at as distant intervals as possible.

These several courses illustrate the principle of a good system of rotations, as applicable to the plants commonly cultivated in this country, and they are all capable of being reduced to practice upon the farm. They may serve as the basis of other courses, where plants not enumerated here are to be introduced into the course.

VII. CULTIVATION OF PLANTS.

I. PLANTS CULTIVATED FOR THEIR SEEDS.

1. *CEREAL GRASSES.*

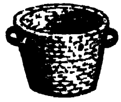
Of the cereal grasses, the most commonly cultivated in this country are wheat, barley, oats, and, in a lesser degree, rye. These present certain common characters, and admit, to a considerable degree, of a similar mode of culture. Before, therefore, treating of the species, it will be well to consider those circumstances with respect to culture in which the kinds enumerated agree.

The seeds of these cereal grasses may be sown either previously to winter or in spring; wheat and rye are, for the most part, sown before winter; barley and oats generally in spring. They may be sown either broadcast or in rows.

When they are sown broadcast, the operation may be performed either by the hand or by a sowing apparatus.

When they are sown by the hand, the grain is contained in a basket, or in a sheet slung over the right shoulder of the sower. This sheet he holds distended by his left hand, and uses the right in sowing. He walks, with a measured step, along the ridge, scattering the grain in a uniform manner across it. He passes twice along a ridge of from 15 to 18 feet, so that each cast is across half the ridge. The corn is placed in sacks in the field at convenient distances, and may be carried by an assistant to the sower in a straw-basket (Fig. 122).

Fig. 122.



Experience teaches the sower to regulate the quantity to the acre, and to scatter it equally upon the surface. An inexperienced sower scatters it unequally, and often with intervals of thinner sowing between the casts.

To render the execution of the work less dependent upon the skill and attention of the sower, and to deposite the seeds with greater equality, the broadcast sowing-machine (Fig. 30) may be employed. This machine is drawn by a horse, which walks in the open furrow, and it is of size sufficient to sow the half of two adjoining ridges, or the space of one entire ridge, at a time.

When this machine is used, the grain is, as in the other cases, brought forward from the sacks in a basket, and emptied into the seed-box. By the revolution of the internal spindle with its wheels or brushes, the seeds fall through the apertures; these apertures being made to be enlarged or diminished, so as to allow the seeds to fall through in the quantity required.

Whether this machine or hand-labour be employed, the harrows are immediately to follow, giving the number of turns required lengthwise and across, until the seeds are sufficiently covered.

When the grain is to be sown in rows, the sowing-machine may move either lengthwise in the direction of the ridges, or across. In the former case it is convenient that the machine be of a size to suit the ridges, so that it may complete each ridge at two turns. The distance between the rows may be 12 inches. After the machine has passed over the land, it is to be slightly harrowed.

The advantages of drilling are chiefly in the case of the lighter soils, and especially where these are apt to be overrun with annual weeds. The intervals between the rows admit of being tilled by the hoe, so that annual weeds may be destroyed before the crop shall cover the ground. This tilling between the rows, too, is favourable to the growth of the plants. In Norfolk and the lighter soils of Suffolk, and indeed very extensively in England, the drill-system accordingly is preferred to the broadcast. In the North of England, and in Scotland, the broadcast system is preferred. When the land is sown broadcast, it admits of no further tillage during the growth of the plant. For the most part, the only weeding which it receives is the pulling up of individual plants, but more frequently by cutting them over by the simple instrument termed a weed-hook.

Fig. 123.

Before the corn shoots, as in the month of June, bands of young persons, or females, with these weed-hooks, pass along the ridges, and cut over the thistles, docks, or larger weeds; which is generally sufficient to prevent their rising to seed, and interrupting the reapers in harvest.

When the corn, however, is sown in rows, it admits of being hoed in spring. This is sometimes done by a horse-hoe. But the more general method is by the hand-hoe (Fig. 79). Each hoer generally takes one row, hoes the earth as near to the growing corn as possible, and pulls up also by the hand any weeds amongst the corn.

The cereal grasses receive no other tillage during their growth, except an incidental one when the grass seeds are sown amongst them in spring. The grass-seeds are sown broadcast upon the surface, and then covered by the harrows or roller.

In the end of summer, when the green colour of the stem has nearly disappeared, and when the grain, having changed from its milky state, has somewhat hardened, it will be proper to commence the process of reaping. It will not be necessary to delay the operation until the grain shall have become what is termed dead-ripe; for before this state of the plant has occurred, the grain will have attained its maturity of size, and the sap have ceased to ascend to nourish it, and the process of hardening will proceed equally well, although the stem be separated from the ground. By cutting before the state of extreme ripeness, hazard from winds and rains will be lessened, as well as the loss from shaking out the grain during the reaping and removing of it; and the straw will be secured more full of nutritive juices, and more fit for the purposes of provender.

In the reaping of corn the stems should be cut as horizontally and close to the ground as the nature of the instruments employed will admit. They should be laid in rows or bunches, with the heads in one direction, in such a state as to be easily collected and bound into sheaves, and all this with the least waste of grain and the greatest economy of labour.

The instruments employed in reaping are the sickle and the scythe. The blade of the sickle is smooth or serrated.

Fig. 124.

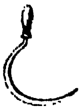
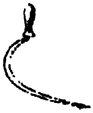


Fig. 125

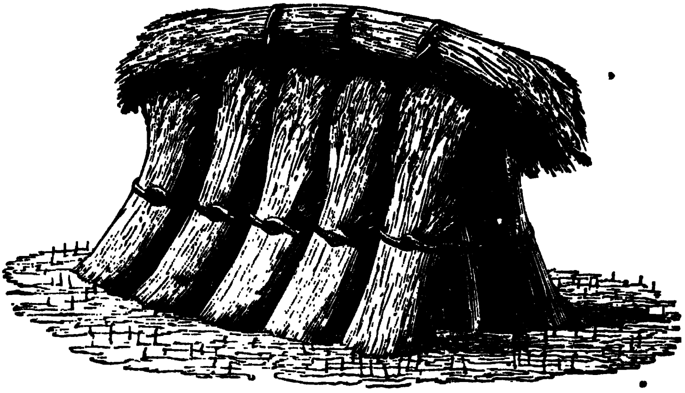


In using the sickle, the reaper holds the instrument in his right hand, and seizing the stems of corn by small portions with his left, he cuts them horizontally through within a few inches of the ground, by pulling the sickle towards him. When he has collected as much as he can conveniently support by his hand, he lifts the whole up by the aid of his sickle, and lays it on a short rope, formed of the stalks of corn, and laid upon the ridge behind him. When a sufficient number of these handfuls is laid upon the rope, another person who follows binds the whole up into a sheaf.

To arrange the reapers in the field in the way best suited for despatch, let 3 be placed upon each ridge when the breadth is less than 18 feet, with a man for every 6 reapers, to bind the sheaves, and place them upright in the way to be described. Let it be the duty of the centre reaper of each ridge to make also the ropes or bands by cutting, or when the corn is very short by pulling, a small handful of the corn, twisting it together at the ear-end, and dividing it into two smaller parcels; and let this band be laid down upon the stubble behind him. When the ridge, however, is 18 feet or more in breadth, there may be 4 reapers upon each ridge, and then there must be 2 binders for every three ridges, being 1 binder for every 6 reapers as before.

The binder having tightly bound the sheaves, he places them upon every alternate ridge, resting upon their bases, and upon one another. Five pairs of these sheaves, when the crop is oats or barley, and six pairs when it is wheat, may be conveniently placed in rows together; and in the case of the oats or barley, the whole may be covered by two sheaves, the but-ends of which lie towards each other, with the ear-ends divided a little, and pulled down so as to cover and defend the upright sheaves, thus making twelve sheaves to each shock. In the case of wheat, the stems of which are hard and dry, and which requires to stand in the field only a few days before it is ready to be carried home, the head-sheaves are omitted. In the case of oats and barley, which, on account of the great softness of their stems, require to stand a longer time in the field, the head-sheaves are used for the purpose of securing the upright sheaves against the effects of the weather.

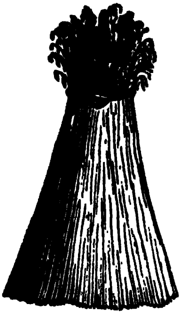
Fig. 126.



The shocks should be set nearly north and south, so as to be equally dried by the sun on both sides. By means of the head-sheaves, the other sheaves are protected from an ordinary shower, which runs off from the convex surface, and the whole stand till they are sufficiently dry to be transported to the barn-yard.

There is one variation from this method of arranging the sheaves to be noticed. It is ever proper to cut crops of corn when dry, but often, from the effects of dews and rains, the crop is in a moist state when it is necessary to reap it. In this state, and the observation applies chiefly to oats, it might be unsafe to unbind the sheaves tightly at once, lest they should become mouldy or the ears sprout. In this case the rope may be drawn very loosely round the sheaf, and nearer to the ears, so that the bottom may be stretched out, and each sheaf made to stand separately upon its own base (Fig. 127). In this state the sheaf is less protected from the injuries of the weather, but a readier access being allowed to the air, it dries sooner, and is not so apt to be injured when it has been put up in a wet state. Before these loose sheaves are removed from the ground they ought to be bound tightly together in the same manner as the others, and either carried at once to the barn-yard, or placed in regular shocks until it shall be convenient to remove them.

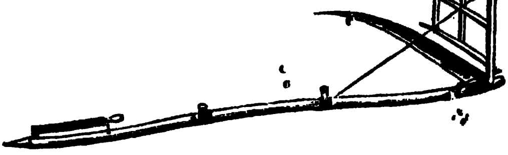
Fig. 127.



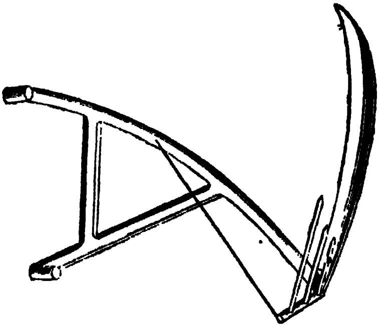
In this whole process of reaping, a very minute care is necessary in causing all the parts of the work to be well and diligently executed. It is especially important that the reapers be made to cut as low as can conveniently be done; for in this way only will the stubble be left clear of loose and straggling heads. Further, the straw of this class of plants is always more succulent near the root, and a slight difference in the height of cutting will make an essential one in the weight and value of the straw produced.

The other instruments usually employed in reaping, are scythes of different kinds. The common scythe may be employed for this purpose, in which case there should be attached to it an apparatus (Fig. 128), for the purpose of supporting the stems, during the action of the blade, and laying down the corn with regularity.

Fig. 128.



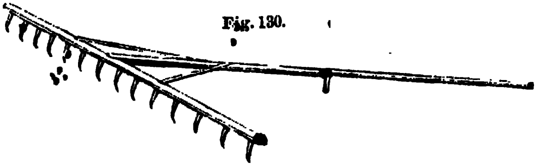
This apparatus, usually termed a *cradle*, may consist of three slightly bent pieces of ash, mortised into a piece of wood, which is attached to the end of the lower part of the handle, so as to be vertical when the scythe is at work, and the upper part is fixed by a rod or cord passing from it to the handle. The three pieces of ash stand above the scythe, and parallel to it, and are of such a length as to extend over half the blade or more. In place of the common scythe here described, there has been recently introduced one with two handles, which, by placing the mower in a less constrained position, is more easily worked.



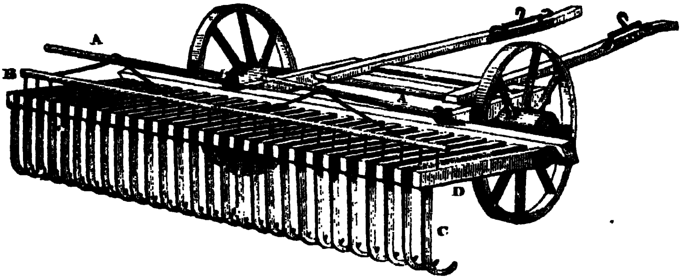
The mower cuts from right to left. In some parts the practice is, for the mower to cut towards the standing corn on which, accordingly, the cut corn rests, assistants following close to remove it. But the better practice is, for the mower to cut towards the open side. In this manner, the corn is laid down with considerable regularity.

Each mower is followed by one person, to make the bands, and lay the corn upon them. A person follows immediately, and binds up the sheaves, precisely as is done in the case of reaping with the sickle. Another person follows every two mowers with a large rake, with curved-iron teeth (Fig. 130), to rake the stubble.

Fig. 130.



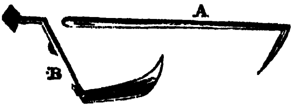
In place of the hand-rake, rakes drawn by horses may be employed. The following is an example of one of this class of instruments, so formed that each tooth moves independently of the other. The teeth are of iron, fixed each to a separate handle of wood, and all the handles are attached by their extremities to a rod of iron, on which they are moveable. Further, the handles are all separately attached by chains to a common bar, and this bar being attached by chains to handles held by the workman, the whole teeth can be lifted from the ground at once, and the collected stems of corn allowed to fall down. In the figure, C is one of the teeth, D the handle to which it is fixed, B the common bar to which the handles of the teeth are attached by chains, AA the handles held by the workman, and attached by chains to the bar B. Further, the bar B may be divided into two parts, so that one-half only of the teeth shall be raised at the same time.



Corn mown by the scythe is cut closer to the ground than is common in practice by the sickle, and the stems being less compressed together, they are sooner ready for being carried home than when reaped by the sickle. The sickle excels the scythe in this, that the corn is laid down more regularly, with the heads in one direction, a point of importance in all cases, but especially when the thrashing machine is to be used.

An instrument surpassing the sickle in despatch, and the scythe in the regularity with which it lays down the reaped corn, is the Hainault scythe (Fig. 132), The workman holds in his left hand the bent instrument A, with which he presses upon the corn about the middle, and he then strikes it near the root with the scythe B, which he holds in his right hand, laying the cut against the standing corn. He employs the bent instrument and the scythe to collect the corn. This method of reaping is practised in Flanders; and a similar method, though with a different instrument, is followed in some parts of England.

Fig. 132.



Whatever be the means employed to reap the corn, it ought not to be left loose upon the ground, but secured in sheaves and shocks until it can be transported from the field. This is required, at least in a moist and uncertain climate.

When the corn has remained a sufficient period in the field for the juices in the stem to be dried, and when the sheaves are freed from external moisture, it will be time to convey the crop from the field, and to secure it in a place of safety. A certain exhaustion of the natural juices is necessary; for otherwise the mass, when collected together in quantity, and excluded from the air, would ferment. While, therefore, no favourable occasion is to be neglected of securing the crop, its subsequent safety must not be endangered by precipitation. The proper time for its removal will be learned by a little practice in the fields. The sheaves should feel light when lifted up, and no particular sensation of cold or damp should be experienced in thrusting the hand into the body of them. In four or five days of good weather, wheat will generally be fit for carrying home, and oats and barley in twelve or fourteen. But the process may be retarded when the air is moist, and without wind, and still more when rains intervene. In this case, the ear will often sprout, and the straw become injured. Frequently, in these circumstances, the head-sheaves must be removed to give access to the air, and often the entire sheaf spread out during the intervals of sunshine.

The corn being ready, the sheaves are to be forked into the cart or waggon. The cart employed is sparred at the sides, and has a projecting frame-work all around (Fig. 56). The sheaves are built on the carriage by the driver, another person forking them to him from the shocks. In building, he lays courses along each side, the but-ends outermost, filling up the heart by sheaves laid lengthwise. In this manner he proceeds, until he has built the load to the height to which it can be with safety raised, when two ropes, one fastened to each side, are thrown over the load, and tied tightly at the opposite sides; but when the distance is short, the tying with ropes is omitted.

The corn is then to be secured in stacks built near the barn, —a practice greatly superior to that of securing it in large houses or barns in a climate like that of Britain. When placed in this latter situation, the corn requires to remain longer in the fields before it can be safely stored, is more subject to injury from various causes, and, being too much excluded from the external air, does not keep so safely.

The stacks may be made circular, with a diameter of 12 feet or more, according to the convenience of the farmer, and the size of his barn. The manner of working is this:—

A circular layer of straw, or other substance, is laid, to form the bottom. The workman begins by placing a sheaf upright in the centre of the intended stack, round which he places other sheaves, also on their but-ends, with the tops inclining inwards; and this he continues to do in regular courses, the sheaves being placed closely together, until he nearly reaches the outside of his foundation. He then lays an outside layer all around, the buts being outwards, with the top and upper half of the sheaves resting upon the inner ones. In this operation of laying the exterior layer, he first grasps a sheaf, and then, placing it close to, and somewhat upon, the sheaf last laid, he presses upon it with his hands and the weight of his body, and lifts himself forward, until he has placed his knees upon it: and then, grasping another sheaf, he, in the same manner, places it in its position, and so moves on from sheaf to sheaf. He thus lays a layer of sheaves all around, and then a second layer, in the same manner, filling up, where necessary, the interior of the stack, until he has raised the whole nearly to the same level as the top of the upright sheaves before mentioned.

Having completed this first part of his work, that is, having laid his outside layers, and filled up the heart, so that the whole may be nearly level, but with a slight dip from the centre outwards, he proceeds thus :—He lays his second course of sheaves all around, with their buts about 15 or 18 inches further back than those of the outside course. Having done this, he fills up the interior of the stack ; but, in filling up the interior, he does not generally observe the same order of courses which he does in laying the outside layers ; he merely packs the sheaves in a proper manner, so that they may fill up the whole interstices. He now lays an outside layer all round, with the buts outward, as before, and the ear-ends slightly elevated, by resting upon the buts of the last laid or inner course. Thus he proceeds, alternately laying the outside and the inner course, and filling, as he proceeds, the heart or interior, carefully preserving, as has been said, the dip of the sheaves from the centre outwards.

Sometimes when the stack is very large, or the straw short, more than two internal courses are laid. The process, however, is the same. The different courses overlap, and the workman proceeds by laying the courses in succession upon each other, and filling up the heart.

When the workman has carried his stack to the height of 12 feet, or more, he begins to contract it. But he first lays a course projecting a few inches beyond the outer course last laid. This is intended to form the eaves of the roof; but often this is dispensed with, and is not essential.

After this he contracts the stack, each successive course of sheaves being laid more inwards. At the same time, the elevation of the centre is not only preserved, but increased, so that the sheaves may have an increased obliquity as the upper part of the stack is formed.

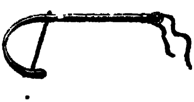
When the workman has contracted the top to a platform of three or four feet in diameter, he rises from the position in which he has hitherto worked, and places a sheaf upright in the centre, and this he surrounds with sheaves standing in like manner upright, but with their tops inclining inwards, and leaning upon the centre sheaf. This summit of upright sheaves he firmly surrounds with two or three turns of a straw rope, the ends of which are sometimes fixed to opposite sides of the stack, so as to prevent the summit from being blown down.

The stack is now in the form of a cylinder with a conical top. It is usual to make the diameter of the stack increase as it rises in height. This deviation from the perpendicular, however, should be very slight, as it tends to render the stack more apt to incline to one side.

The stack is now to be thatched, after it has subsided a little, and it is proper that a certain quantity of straw be in readiness for the purpose. The straw is formed into bunches, by drawing it out by the ends into handfuls: the short straw which is separated in this operation is reserved for other purposes, as forming the bottoms of the stacks, and partly also for thatching.

Twisted straw-ropes are to be in readiness. They may be made by means of the simple instrument, Fig. 133. It consists of a handle of from two to three feet long, bent at one end like a bow, and having at the other a ring and swivel, through which ring a straw rope is passed, which is tied round the waist of the worker. The straw to be twisted is fixed to a notch at the end of the bow, and gradually supplied by a person from a heap. The other worker, who may be a very young person, the work requiring no exertion of force, walks backward turning the bow round with one hand, until the rope is formed of the length required. The ropes thus formed are coiled upon the arm, and reserved for use.

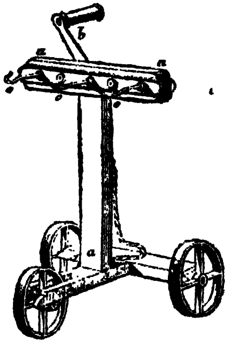
Fig. 133.



In place of the instrument described, one may be employed to twist more than one rope at a time. It is formed upon the principle of the common rope-making machine. It is attached to the body of the workman, who walks backwards, turning the handle.

The workman who thatches the stack stands upon the roof. The bunches of straw being handed or forked to him, he

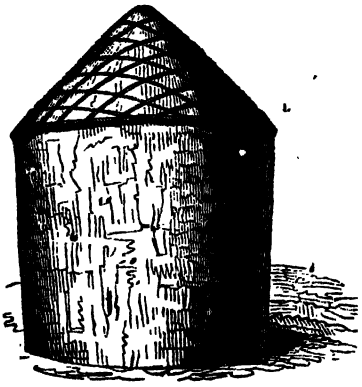
Fig. 134.



spreads the straw in handfuls all around the stack, laying successive layers until he reaches the top, the higher overlapping a little the lower; and he takes care, by working backwards, not to tread upon the straw already spread. When he reaches the upright sheaves at the top, he lays a thick row of covering on, which may consist of short straw, which he draws to a point at the top, and makes tight with a thin straw-rope wound round it.

The straw is then fastened down by means of the straw-ropes already described. The thatcher stands upon a ladder aloft so as to be able to reach the summit, while two assistants remain on the ground below, or are supplied with short ladders. He lays the ropes over the roof in a series at the distance from one another of 12 or 15 inches. They are passed obliquely over the roof, and fixed to, or wound round, another rope placed above the eaves, or below them as in the figure.

Fig. 135

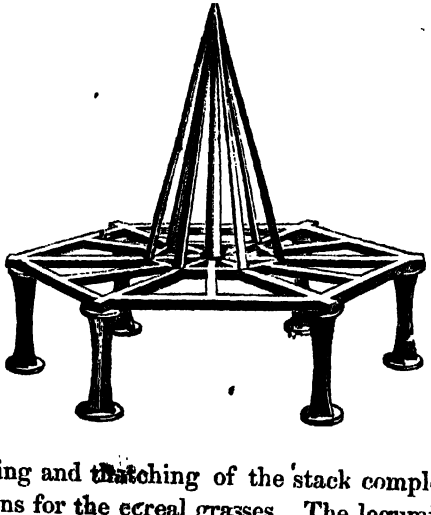


Considerable danger arises in wet seasons, if the corn is carried home in a damp state; but this may occur in any season, if the straw is not freed of its natural juices before being carried from the field. The incipient fermentation is denoted by the great heat of the interior of the stack, which will be rendered sensible by thrusting in the shaft of a fork, and feeling it when it is withdrawn, or by pulling out a handful of corn, or by merely thrusting in the hand. If the heating proceeds so far as to threaten injury to the stack, the whole should be turned over and rebuilt, or carried to the barn and thrashed.

In wet seasons farmers are frequently obliged to form their stacks hollow in the centre, so as to allow the access of the air. This is done by placing upright posts fastened at the top, and stretched out like the legs of a theodolite, and building around them. An opening being made in this hollow from the exterior of the stack, a current of air is admitted.

Often stacks are placed on pillars of stone, or of cast-iron, as in Fig. 136.

Fig. 136.



The building and thatching of the stack complete the harvest-operations for the cereal grasses. The leguminous plants cultivated for seeds are secured in the same manner.

The stacks being secured, remain until it is convenient to thrash the corn and prepare it for use. The threshing by the flail is a work of labour, and notwithstanding every care a considerable part of the grain remains attached to the straw.

Labour proceeds slowly at a time when despatch may be important, and the thrashed corn remaining generally for a considerable time in a heap is subject to injury of various kinds.

For these reasons, the invention of the thrashing-machine is to be regarded as important in the progress of improvement. The farmer by means of it is enabled to get his work performed at once and with despatch, and in a more perfect manner than is usually done by manual labour. It is in these things rather than in the saving of expense, that the superiority of the thrashing-machine over the flail consists.

The thrashing-machine has always a winnowing-machine attached, and forming a part of it, by which the grain is partially freed from the chaff and impurities. Sometimes two winnowing-machines are attached to the larger class of thrashing-machines; but this is rare, and where there is only one winnowing-machine, the corn, as it is received from the thrashing-machine, undergoes a further process of winnowing in a separate machine, in order to be fully cleaned.

The thrashing-machine performs three operations:—First, it beats the grain and chaff from the straw, by means of the beaters fixed upon its revolving cylinder; second, by means of its revolving rakes it shakes the chaff and intermingled seeds from the straw, which last is separately thrown out of the machine; and third, by means of the attached winnowing-apparatus, the seeds are separated from the chaff, and being received from the machine, are carried away to undergo a final dressing in a separate winnowing-apparatus. The barn for these operations, it has been seen, is divided into three apartments:—First, that in which the unthrashed corn is put; second, that immediately underneath it, in which the corn is received from the thrashing-machine, and afterwards winnowed; and third, that into which the straw falls from the thrashing-machine, and where it is generally stored for use. This last is termed the straw-barn, and ought to be of a size sufficient to contain the produce of two stacks.

The first operation to be performed in thrashing is to carry the unthrashed corn from the barn-yard to the barn. A piece of canvass is laid at the side of the stacks for the sheaves to fall upon. The sheaves may be carried to the barn by two persons, on a piece of canvass fixed on two poles (Fig. 137); or they may be conveniently carried on light sparred barrows. (Fig. 138.)

Fig. 137.

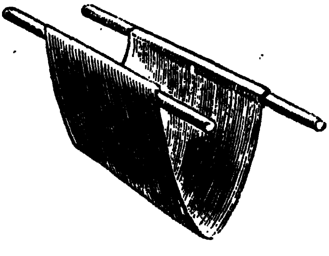
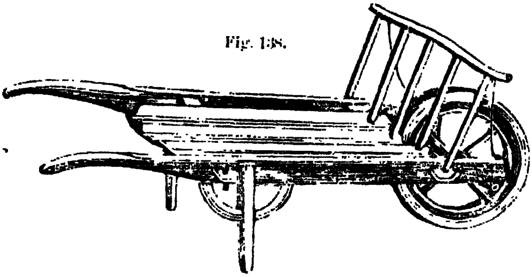


Fig. 138.



When the machine is put in motion, one person is employed to carry forward the sheaves, another to lift and lay them sheaf by sheaf upon a table adjoining the feeding-board. The duty of the person who lays the sheaves on the table, is to loosen them, untwisting at the same time the bands, and laying them in the direction of the sheaves. The person who stands at the feeding-board takes the unthrashed corn from the table, and spreads it upon the board, pressing it forwards towards the fluted rollers. His duty is to convey it in due quantity to the machine; and generally, to observe that all is right with regard to the machinery. Two persons, generally females, are employed in the dressing-barn, to convey away the grain as it comes from the thrashing-machine. Two are employed in the straw-barn, one to take away the straw as it falls from the machine, and to pile it up in the straw-barn, and another to build and tread it; and, where animal power is employed, one person drives the working cattle.

The taking away of the grain from the machine is carried on continually by the two assistants in the dressing-barn, in riddles (Fig. 139 and 140).

The winnowing-machine, from the description formerly given of it, will be seen to separate the corn into three parts,—first, the chaff which is blown away—second, the heavy and useful corn—and third, the intermediate or light corn. The winnowing-machine attached to the thrashing-apparatus, performs in a certain degree these operations. The chaff is blown away and is received into a separate chamber. The light grain is received at one aperture, and the heavy grain at another; but the winnowing-machine is so formed and regulated that a small portion only of the light grain is separated from the heavy. The greater part of the light and the heavy grain is made to come out at one aperture; while that which comes out at the other aperture is but a small proportion of the light mixed with pickles with the chaff attached, broken ears, and other substances. Now, the assistants in the dressing-barn collect in their riddles, first the heavy mixed with light corn, which falls from one aperture of the machine; and next the small proportion of light mixed with heavy substances which falls from the other: and they proceed in the following manner:—

At the aperture from which the corn, properly so called, falls, they receive it in their riddles (Fig. 140), and riddle it into a heap. What falls through the riddle is corn; what is retained in the riddle is broken heads of corn, chaff, and other substances. This refuse is thrown aside, or more frequently it is thrown amongst the mass of similar substances which are falling from the second aperture of the machine. Now, with respect to the substances falling from this latter aperture, they are also collected by the attendants with riddles and much wider meshes, called slap-riddles (Fig. 139), and riddled into a small heap. What falls through is corn mixed with chaff and other substances. What is retained is broken heads of corn, short straws, and the like. These are thrown aside as refuse, or carried again to the feeding-board, and passed through the thrashing-machine, so that the broken heads may be subjected to a further thrashing, and thus the remaining corn be separated from the straw.

There are now two heaps, one consisting of the great mass of corn and the other much smaller, consisting chiefly of the light corn and chaff, which had passed through the meshes of the slap-riddle. This completes the operation of thrashing, as it is effected by the thrashing-machine and its attached fanners. The corn is now to be finally dressed and prepared for use in a separate winnowing-machine.

The winnowing-machine was before described. The corn, it was seen, is put into the hopper, and falling down upon the wirework below, is acted upon by the air of the fanners. The chaff is blown out at the end of the machine. The heavier corn falling down, is conveyed by an inclined plane to an aperture where it is received: while the inferior corn, not sufficiently light to be blown away with the chaff, nor sufficiently heavy to go with the superior grain, falls into an intermediate space, and thus is separated from the heavy grain on the one side, and the chaff on the other. Both the heavy and the light grain, which last is in comparatively very small quantity, are riddled into their respective heaps, and the refuse retained in the riddle is thrown aside.

In applying the winnowing-machine to complete the dressing of the corn, it is placed in a convenient situation near the corn to be winnowed. For bringing the corn from the heaps to the hopper, close sieve-like implements (Fig. 141), capable of holding about half a bushel, are used. One person is sufficient for this duty, and for filling the corn into the hopper. One person may conveniently collect the heavy corn as it falls from the machine, and carry it in the same sieve-like implement to two persons employed in riddling, and divide each portion between them by pouring it into their respective riddles. This at least is a convenient distribution of labour, but the intermediate worker may be dispensed with. The persons employed in riddling, riddle the corn into its heap, and throw aside the refuse. The light or intermediate corn is riddled into a heap as it accumulates.

The whole corn, then, is divided into the following parts—first, the heavy or superior grain—second, the light or inferior grain—and third, the chaff, straw, and refuse.

The implements employed for these operations are—

1. The thrashing and winnowing-machine already described.

2. The close implement for carrying corn, and the sieves for riddling or shaking it through. These last are sometimes made of wire, but they are more simply and better formed of splints of ash; the meshes being of different sizes, suited to the different kinds of grain.

Fig. 139.

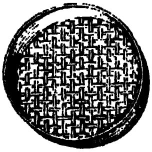


Fig. 140

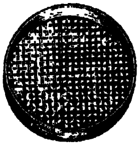


Fig. 141.

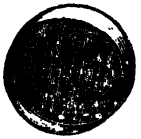
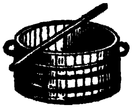


Fig. 142.



3. A vessel for measuring corn, with a flat stick or roller for passing over the top and levelling the corn. This measure may contain a bushel. Fig. 142.

4. A wooden shovel for shovelling corn into heaps. Fig. 143.

5. A loadbarrow for carrying filled sacks. Fig. 144.

Fig. 143

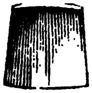
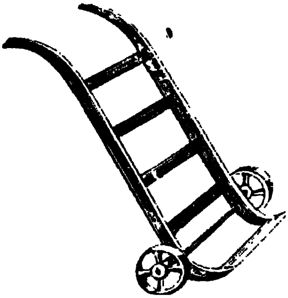


Fig. 144.



The heavy or superior grain is intended for the various purposes of consumption to which the different kinds are suited. The common practice of the farmer is to convey it as quickly as possible to the miller or intermediate trader in corn. For this purpose, as soon as it is winnowed in the manner described, it is measured, and put into sacks capable of holding a determinate quantity, as half a quarter. In these sacks it is conveyed to market; and sometimes, from particular causes, the farmer stores it in granaries, spreading it upon the floor until it is required for use.

The lighter or inferior grain is usually employed for the feeding of the animals upon the farm.

The straw is used for various purposes of domestic economy and the arts; but its main consumption upon the farm is for the purposes of provender and litter. The chaff also is used as fodder for cattle.

Of the straw of the different kinds of the cereal grasses, that of the oat is the most valued in this country for fodder; that of wheat and barley is chiefly used for litter. The quantity produced varies greatly. It may be held on a medium to weigh from 20 cwt. to 30 cwt. per acre. Wheat produces the greatest weight, oats the next, and barley the smallest, as well as the least valued also for its quality.

1. WHEAT.

Having thus treated of the cereal grasses in general, we are prepared to consider the characters, uses, and modes of culture of each. They are divided into genera, and these again into species, and minor varieties or kinds. The first in the order of description of the genera, and the most important as the food of man, is Wheat.

Of the genus *Triticum*, the following species may be enumerated as admitting of cultivation for their seeds:—

1. Triticum æstivum—Summer Wheat.
2. Triticum hybernum—Winter or Lammas Wheat.
3. Triticum compactum—Compact Wheat.
4. Triticum compositum—Egyptian Wheat.
5. Triticum turgidum—Turgid Wheat.
6. Triticum atratum—Dark-spiked Wheat.
7. Triticum hordeiforme—Barley-like Wheat.
8. Triticum Zea—Far.
9. Triticum Spelta—Spelt.
10. Triticum monococcum—One-grained Wheat.
11. Triticum polonicum—Polish Wheat.

Triticum æstivum, Summer wheat, has awns both on the calyx and corolla. Each spikelet has usually five florets, of which two are barren.*

Summer wheat requires a shorter period to complete its vegetation than any of the other kinds. It is the prevailing species of warmer countries, and is cultivated in many parts of Europe. Its grains are for the most part small, and the produce of its straw is less than that of some other species when cultivated under the same circumstances. The trials that have been made with it in this country have shown it to be inferior in productiveness and quality to the better kinds of the winter wheat. The advantage which it possesses is the earlier period of its ripening, on which account it may be sown so late, even in this climate, as the beginning of May.

Triticum hybernum, Winter or Lammas wheat, is distin-

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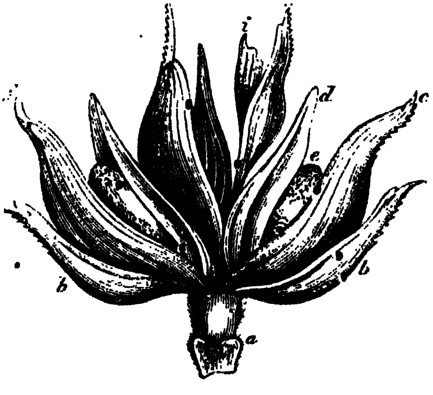
* The calyx of wheat consists of two valves or glumes, enclosing several florets. In each of these florets there are two valves, forming the corolla, and enclosing the seed. Sometimes the corolla encloses a perfect seed, and sometimes the seed is not perfected. Each calyx, with the florets which it encloses, is termed a spikelet. The part to which the spikelets are attached, is termed the rachis or shaft, and the spikelets, placed one above the other on each side of the rachis, form the ear or head. The rachis is jointed, and the spaces between the joints are termed the internodii. In the following magnified figure of a spikelet of *Triticum hybernum*—*a* is a joint of the rachis,—*bb* the calyx, or calycine glumes,—*cd* the glumes, or valves of the corolla,—*e* a seed,—*f* another floret with a perfect seed,—*g* a third perfect floret,—*h* a fourth imperfect or abortive floret,—*i* a fifth imperfect or abortive floret.

Fig. 115



guished from the last, by having no awns upon the calyx, and only short awns upon the corolla, near the summit of the spike. But the awns not being a good botanical character, many botanists have conceived the species to be the same. But the characters of either kind being permanent, and remaining, under given circumstances, unchanged for an unknown period, they may be regarded as species. The winter wheat has usually five or six florets, of which two are barren.

Winter wheat is that which is the most important with relation to its cultivation in Northern Europe. It is, in this country, generally sown previously to the months of winter; but it is an annual plant, and may be sown in spring.

Triticum compactum, Compact wheat, is allied to the two last named species, and may be merely a variety of them. In it the internodii of the rachis are very short. It is partially produced in different parts of Europe. I have received specimens of it from France and from Sweden, and have cultivated them, without observing any change of characters. Whether, however, the characters which distinguish it are sufficiently permanent to entitle it to be regarded as a species, has not been determined. In the mean time, following the authority of Host,* I have placed it amongst the species.

Triticum compositum, Egyptian wheat, is distinguished from the others by its branched or compound spike, which no other species tends, under any circumstance, to produce. Its seeds are numerous, and the produce abundant. It requires a good climate and a fertile soil, for, in unfavourable situations, the branches of the spike are not evolved, and then it assumes the appearance of ordinary wheat. It is cultivated in Egypt and the East, as it is in the south of Europe and different parts of Italy. It was known in Germany about 240 years ago;† and in France it is said to have been cultivated for about eighty years, having been brought from the East under the name of Wheat of Smyrna. In England it has been partially cultivated as the subject of experiment.

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* Icones et Descriptiones Graminum Austriacorum.

† Eicones Plantarum, Francofurti ad Moenum, MDXC.

In the next species, *Triticum turgidum*, Turgid wheat, the corolla is awned, but not the calyx, the spikes are covered with soft hairs, and in some varieties change to a dark colour, and the awns drop off as the seeds become ripe: in which respects it differs from summer-wheat. It is termed with us Grey-wheat, Duck-bill-wheat, Grey Pollard, Rivet, Pole-Rivet, Cone, Pendulum, &c.

This species grows very tall, with a thick and rigid stem. The spikes are large and heavy, and nod to one side as the grain increases in weight. The kinds or minor varieties are distinguished by the farmer from their qualities of earlier or later ripening, and greater or less productiveness. One of the most esteemed of these is Cone-wheat, so named from the conical form of its spike.

The turgid wheats are productive in corn and straw, but the grain is coarse and hard. They are chiefly suited to the inferior clays, upon which, in England, they are extensively cultivated. They are valued, under such circumstances, for their productiveness in grain, and their large growth of straw; but being inferior to the winter-wheats in the quality of their produce, the cultivation of them is not likely to be extended in this country.

Triticum atratum, Dark-spiked wheat, is allied to the last species, if it is not rather to be regarded as a variety of it. I obtained it from Africa, and it is not improbable that the turgid wheats are derived from that country. The dark-spiked wheat has merely been made the subject of experiment, but not of extended cultivation. It is not superior in productiveness to the turgid wheats in common use.

Triticum hordeiforme, Barley-like wheat, so named from its peculiar form resembling that of barley, seems also to be derived from Africa. It resembles the last species by its florets being awned, and by its calyx and corolla becoming dark as the seeds ripen. But it resembles the class to be next referred to, termed Spelt-wheat.

Triticum Zea, Far, is one of the class of spelt-wheats. It is distinguished by the distance of its spikelets from one an-will remain unchanged for an indefinite period. Under other circumstances, however, they degenerate ; and hence particular kinds that were once valued have now ceased to be so.

Wheat is of very general cultivation on all classes of soils ; but the soils which are best suited to it, are those which are more or less clayey. So peculiarly is wheat suited to the stiffer soils, that these are familiarly termed wheat-soils. The soils of the lightest class are the least suited to wheat ; and it is an error in practice to force the production of wheat on soils, and under circumstances, which are better suited to the production of the other cerealia. Wheat in this country does not admit of being cultivated at a great elevation. A general rule, applicable to all cases in which wheat is sown, is, that the land shall be in the best condition that circumstances allow, with respect to tillage, cleanness, and fertility. As wheat is the most valuable of the cereal grasses, so it requires greater care than the others to produce it. It is an error to sow with a corn-crop any land which is out of order ; but this error is greater and more hurtful in the case of wheat than of the other cerealia.

Wheat is always to be sown before winter, when the land can be then prepared to receive it. The sowing of it is deferred till spring, when the crops which it is to succeed in the rotation cannot be removed till that season. It is sown before winter after summer-fallow, potatoes, or beans, because, in all these cases, the ground can be fitted to receive the seeds at that time. It is sown in spring after turnips, cabbages, and such other crops as are not usually removed from the ground till spring.

The fitting place of wheat in the rotation is upon land that has been in summer-fallow. In this case, the land is to receive previous to the wheat being sown, what is termed the seed-furrow ; as soon after which as convenient the seeds may be sown. The best period for sowing is from about the middle to the end of September. The seeds, previously to being sown, undergo an operation peculiar to wheat, termed pickling or steeping. This is intended to prevent a disease to which the cultivated Tritica are subject, termed *smut*. The best substance which can be employed for the purpose of steeping is stale urine, which should be in readiness when the period of sowing arrives. The process of steeping may be thus performed:—

Let a tub be provided, and partly filled with urine, and let a quantity of wheat, as a bushel, be put in at a time. Let the wheat be well stirred, and all the lighter grains which come to the top skimmed carefully off, and thrown aside as useless. The wheat should remain from five to ten minutes, but never more than ten minutes, in the pickle. The successive portions of wheat thus pickled are to be allowed to drain a little, and then to be laid upon the barn-floor in layers, hot lime being at the same time sifted upon each layer. The purpose of spreading the lime is to dry the grain, which should then be carried immediately to the fields and sown. The lime used should be quite hot, and for this purpose it should be slacked at the time. Although the immediate purpose served by the application of lime is drying the grain, it may be believed that it also assists the action of the brine in removing the tendency to the disease.

A very strong pickle of salt dissolved in water may be used instead of urine; but salt-brine is not quite so secure a mean of destroying the infection of the disease as urine; and the latter, therefore, ought to be preferred.

The wheat, after being pickled, must not remain long unsown, otherwise its vegetative powers may be injured or destroyed. No more should be pickled at a time than can be then sown. When, from any cause, as from rain intervening, it is not practicable to sow the wheat for a day or two, it should be spread thinly upon the floor, but never kept in sacks, in which it would soon ferment.

The wheat, when pickled, then, is to be carried directly to the field. It may be sown, either by the hand or by the broadcast sowing-machine, in the manner already described, or in rows by the drill-machine.

When it is sown in drills, the usual distance between the rows is from 9 to 12 inches; but it is conceived that the larger intervals are the better, and that they may, in most cases, be with advantage even more than 12 inches.

The quantity of seeds usually sown is from two to three bushels to the acre. In the case of summer-fallow, the quantity need not exceed two bushels to the acre. When the sowing takes place in spring, the quantity may be extended to three bushels, rather less than more.

When the seeds are sown by the drill-machine, a single or a double turn of the harrows will suffice. When they are sown broadcast, the land must receive several harrowings, but no more than are sufficient to cover the seeds, it being better in the case of wheat that there be a certain roughness of clod. A double turn along the ridge, a double turn across, and again a single turn along, will in almost every case suffice; and often less, namely, a double turn along, a single turn across, and a single turn along. Many farmers prefer finishing with a turn across.

No sooner is the process of harrowing executed than the land is to be water-furrowed in the following manner:—The common plough, with one horse, is to pass once along each open-furrow, and then along the open furrows of the headlands, and to draw open furrows in such hollows of the field as water might stagnate in. A person is then to follow with a spade, to clear out the open furrow of the headlands to the necessary depth; to make channels through the headlands to the ditch, where necessary; to clear out the cross-furrows in the hollows, so as to allow the water to run; and to open up the intersections of the open furrows of the ridges with these cross-furrows, and the furrows of the headlands.

The best period of sowing, it has been said, is from about the middle to the end of September. The early part of October, however, is well suited to the sowing of wheat, and it may be continued till the middle of November.

Wheat may be advantageously sown after potatoes. This crop is generally removed from the ground early in October, which admits of the wheat being sown before winter. In the case of this crop, the land being first harrowed, it is then formed into ridges, and the wheat is sown upon these, precisely as in the case of summer-fallow.

Wheat may be sown after a crop of beans, before winter. When the beans are removed from the ground, the land should be well harrowed across, the effect of which is to level it. The ridges are then to be ploughed by gathering the old ridges, the traces of which are not generally obliterated. The wheat is then to be sown precisely as in the case of summer-fallow; and the same careful attention is necessary, as in all other cases, to the clearing out of the furrows and cross channels, so that no water may stagnate upon the surface.

Wheat may be sown after pease, and then the management is the same as in the case of beans.

Wheat may be sown after turnips, and other plants of the cabbage family. If they can be removed before winter, the wheat may be sown at that time; but as these plants generally are not removed from the ground till spring, the wheat is in this case sown in spring. The land is ridged up once, and sometimes receives in addition a seed-furrow, and the wheat is sown as in the case of summer-fallow or potatoes.

Wheat may also be sown after beet, carrots, and parsnips, and is treated precisely in the same manner as when sown after turnips. If the crops can be removed before winter, the wheat is then to be sown; if not, it is to be sown in spring, and the more early in spring the better.

Wheat may be sown after clover and the cultivated grasses. But this is not the true place of wheat in the rotation, oats being the crop that can generally be most advantageously sown after grass. When wheat, however, is sown after these plants, the land may be ploughed once, and the wheat sown in autumn. Sometimes a partial fallowing is given; but this is unnecessary.

A practice prevails in certain parts of England, of planting the wheat upon the clover-lea by dibbling. In this case, the furrow-slice is laid flat, and a light roller made to pass over it.

A man walking backwards with an iron dibble in each hand, strikes two rows of holes in each sod, and he is followed by children, who drop a few grains into each hole; the seed is covered by a bush-harrow, and sometimes by a roller. The quantity of seeds is from a bushel, or even less, to a bushel and a half per acre. Although a seemingly inartificial and rude process, and unsuited to that despatch which is deemed essential on well-managed farms, it is yet found to answer well on the loose and sandy soils on which it is practised.

Wheat, and all the cerealia, have the property of sending out numerous shoots from the roots during their growth. This natural process is termed tillering, and is familiar to all farmers.

It is to be observed, too, that often the roots of the grasses are partially raised above ground, in which case the plant becomes feeble or perishes. This accident sometimes occurs from too thick sowing, and too rapid a growth in that state. But it is more often produced by the sudden contraction and expansion of the soil by alternate frosts and thaws in winter, and in this case the wheat is said to be thrown out.

To promote the process of tillering, and sometimes to prevent the throwing out of the plants, it is found to be beneficial to give a certain tillage to the growing wheat in spring, by means of the hoe, the harrow, or the roller. When wheat is sown in rows, this is done by means of the hoe; when broadcast, by means of the harrow; and in either case the roller may be also used. But this tillage is generally given to it incidentally, and in the course of another operation to be described,—the sowing of the seeds of clovers and the cultivated grasses.

The seeds of these plants are sown as early as convenient in April upon the surface of land on which the cereal grasses are sown. They grow up under the shade of the latter, and in the following season they are fit for use. When the crops of corn with which they are to be sown, are sown in spring, they are generally sown at the same time: But when the crop, as of wheat, has been sown in the previous autumn, the grass-seeds are sown amongst the growing plants, and covered by being harrowed or rolled.

The minute seeds of these plants, consisting of the clovers and ryegrass, or other grasses, are, previously to being sown, carefully mixed together. They are then brought to the ground in sacks, and sown by the hand, or what is better, by the broadcast sowing-machine. In either case, the harrow follows, giving a double turn along the ridges, and the roller may also follow, crossing the ridges, and going over the ground once. In some cases the roller alone is used to cover the seeds.

When the crop is in rows, and hoeing is practised, the seeds may be sown just before the hoeing is given, which then serves the purpose of the harrow. But it is better that the hoeing first take place, and that the seeds be afterwards sown.

The clovers and grasses thus sown, rarely flower in the first year. They grow under shelter of the stems of the larger crop, and they are seen in autumn amongst the stubble covering the surface. They grow during the autumn and winter months, shoot vigorously forth in spring, and are in their greatest luxuriance in the following summer, when they are frequently termed new or one-year-old grass.

The grass-seeds being sown, no further culture can be given to the wheat, during its growth, nor any weeding, except pulling up or cutting over above ground the larger weeds, as docks, thistles, cockle, and the like.

Wheat sometimes becomes too luxuriant in spring, especially when sown early, and then it is apt to be lodged, and run to straw more than to produce grain. In this case, it may be pastured for a short time in the early part of spring with sheep.

The next process in the progress of the wheat culture is that of reaping, the method of performing which is the same as that before described.

The produce of this crop varies greatly with the seasons, the nature of the soil, and the mode of cultivation. A fair good crop may be held to be thirty bushels per acre. The average produce of England does not, perhaps, exceed twenty-two bushels, nor that of Scotland twenty-five. The weight of the straw is reckoned to be about double that of the grain. An acre, therefore, yielding twenty-five bushels of grain, at the rate of 60 lb. per bushel, would yield 3000 lb. of straw, or about 26½ cwt.

The uses to which this grain is applied are numerous and well known.

It is beyond every other grain adapted to the making of bread. It owes this preference chiefly to the greater quantity of gluten which it contains, and to its greater nutritive properties. It is used in various other ways for food. Starch for domestic uses is also derived from it. The grain, being steeped, is beat in hempen bags in water, and thus the starch is separated.

The straw is applied to various purposes of rural economy and the arts. It is used for litter, for which it is well suited. It is used also for provender, but is not so much esteemed for this purpose as the straw of the oat, although more than that of barley. In other countries of Europe, however, it is that which is most esteemed for provender, being generally reduced to chaff. It is used for thatching, to which, from its long and rigid stems, it is well suited. It is used for making baskets, bee-hives, mats, and similar articles; and for the manufacture of hats. The straw, in this latter case, is grown very fine, by being closely sown: it is pulled green, and bleached upon the surface of the ground. The *grano marzolano* of Italy, employed in the manufacture of the Leghorn hats, is a variety of summer-wheat.

Wheat is subject to various accidents and diseases, some of them peculiar to itself. The most dreaded and destructive of these is *blight*, so termed from its effects upon the ear, or *mildew* from its supposed cause, namely *mel-dew*, from an old opinion that it was produced by honey-dew falling from the air.

This disease is indicated by the presence of certain minute plants of the order of *Fungi*, or the mushroom tribe, which grow upon the stem and leaves, and doubtless feed upon and exhaust the juices of the plant. When this occurs at a period so late that the seed is already formed, it does not materially affect it, the straw alone suffering in this case. But when it occurs when the seed is still in an embryo state, the further progress of the seed to maturity is arrested; and it is found when cut down to be shrivelled and abortive.

One of this tribe of plants, and apparently the most destructive, is *Puccinia graminis*, which appears in the form of small spots upon the stem, and gradually extends in lines on the surface. Vast losses have been sustained by the blight produced by this cause.

A disease termed *rust* is also very frequent and hurtful. It appears in the form of a brownish dust upon the stem and leaves: and it is produced likewise by a parasitical plant of the same family.

Another disease of wheat, produced also by minute fungous plants. is *smut*, which differs from rust and mildew in this, that the means of prevention are generally within our power.

There are two varieties of smut. The first resembles a black dust, growing within the glumes of the wheat. It destroys the seed and its envelopes, converting them into a black powder, known by the name of brand, dust-brand, burnt corn, &c. This species is *Uredo segetum*.

The other variety is like a brownish-black dust, consisting of larger grains than the last. It does not appear externally, but fills the seed with a fetid powder: and is greatly the most destructive of the two. It is known to farmers under the name of smut, or ball. The fungus has been termed *Uredo caries*, by M. De Candolle. When affected with this disease, the seed is said to be smutty, blacked, or balled. If the number of grains affected is considerable, the loss is important, both by lessening the produce, and tainting what remains with the black dust of the balls.

Farmers, when their wheat is greatly injured by this disease, sometimes wash it, by immersing it in vats or cisterns partly filled with water. The smut-balls and lighter grains floating to the surface are skimmed off, and the heavy and sound grain after being washed, is exposed to the air to dry, or dried in a kiln with a moderate heat. This practice, however, is rare, and industrious winnowing is the usual method resorted to for freeing the grain from the intermixed balls.

There is no doubt of the infectious nature of this disease. That it is conveyed from the grain to the future plants, may be inferred from the effects of brine and caustic substances upon the grain, as employed in the process of pickling. It has been supposed that the almost impalpable seeds of the fungi are carried upwards by the ascending sap.

These and other diseases of the wheat arise from the growth of parasitic plants, favoured and developed, it may be believed, by circumstances unknown to us. Another class of diseases is produced by the attacks of animals.

Of these the most common, in the early stages of the growth of the plant, are the larvæ of certain beetles. They pass among agriculturists under the general name of grub.

Certain flies also attack the wheat, at a later stage of its growth. The *Cecidomyia Tritici* is a fly with an orange-coloured body and white wings. About the month of June the female ascends the ears of wheat, and deposites her eggs in these by means of a fine trunk, and in a few days she perishes The progeny being hatched in the ear, feed upon the grain. They are very small, from ten to fourteen being sometimes found in one grain, and are distinguished by being of a bright orange colour. They do not extend beyond the grain in which they had been produced; but several grains being thus consumed on each ear, the damage done is often considerable. The larvæ, after a period, fall down to the earth, in which they burrow, and remain there till the following summer, when they ascend from the earth in the form of the beautiful fly which has been mentioned.

These are the principal accidents to which the wheat-plant is subject in this country, from animals and diseases. When stored in the granary it is subject to the attacks of the weevil and other creatures.

2. RYE.

Of the genus *Secale*, there is one cultivated species.

Secale cereale—Rye.

Rye is extensively cultivated in Europe, forming the main part of the bread-corn of the inhabitants of a great part of Germany, Poland, Russia, Switzerland, and other countries.

Rye, with respect to its mode of cultivation, resembles wheat; but it can be grown upon inferior soils, and with less of culture and manure. It differs from wheat in this, that while wheat affects a stiff tenacious soil, rye succeeds best on a light and sandy soil.

Rye may be sown in autumn, or it may be sown in spring; and this circumstance affects, as in the case of other cerealia, the habits of ripening the plant. When sown in autumn, it is termed winter-rye, and when sown in spring, spring-rye. The winter-rye is sown in autumn at the same time as wheat; the spring-rye with the oats, or as early in spring as the weather will allow. Rye shoots into the ear sooner than wheat, and ripens earlier. It stands drought better than wheat, but is more apt to suffer injury from wetness. It is a hardier plant than wheat, and less subject to the attacks of insects and diseases.

Rye is in various countries sown mixed with wheat. The mixture is termed meslin in England; and the two kinds ripen at the same time when sown together.

Rye has sometimes been sown for yielding herbage in spring, and green forage at a later season. Where turnips, however, and the cultivated grasses, are raised, this practice is little adopted.

The bread of rye is dark; sweet, and nutritious, though in this latter property it is inferior to wheat. Mixed in certain proportions with wheat, it makes a palatable and wholesome bread. It is used extensively in the north of Europe, for the purpose of distillation.

Rye rises to a greater height than wheat, and produces a thinner stem, but a great weight of straw. The straw is hard, wiry, and little valued for fodder; but it is used for thatch and other purposes. It is well suited for the manufacture of straw-hats; and, when intended for this latter purpose, it is sown very thick, pulled green, and blanched by exposure to the air.

Rye, though free from the diseases of wheat, is yet subject to a peculiar one. This is the ergot, a fungous plant, which, though it is found on other gramineous plants, is more especially the disease of rye. It is a long cartilaginous-like substance, taking the place of the grain, and projecting from the ear. It chiefly prevails in humid seasons, in close situations, or where the soil is wet. Animals when in a state of liberty refuse it; and when used in quantity amongst bread, it is said to be pernicious, producing gangrene.

The manner of cultivating and managing the rye-crop, is in all essential points the same as that of wheat.

3. BARLEY.

Of the genus *Hordeum*, the following species may be enumerated as cultivated for their seeds.

1. Hordeum distichum—Two-rowed Barley.
2. Hordeum gymno-distichum—Two-rowed Naked Barley.
3. Hordeum disticho-zeocriton—Two-rowed Sprat or Battledore Barley.
4. Hordeum hexastichum—Six-rowed Barley.
5. Hordeum gymno-hexastichum—Six-rowed Naked Barley.
6. Hordeum hexasticho-zeocriton—Six-rowed Sprat or Battledore Barley.*

Hordeum distichum, Two-rowed barley, is the species in common cultivation. The spike is composed of two rows of perfect seeds, the corolla remaining closely attached to, and covering the seeds. The minor varieties of two-rowed barley are numerous, and are distinguished chiefly by the quality of their grain, and by their habit of early or later ripening; and some varieties are more productive than others:—effects apparently dependent upon differences of climate and situation.

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* Barley differs from wheat in this, that each floret has its own calyx. The florets are placed in threes on each of the two sides of the raphis. Sometimes all the three florets on each side are fertile, producing seeds, when the barley is termed six-rowed: sometimes only one floret of the three is fertile,

Barley is an annual plant; but, like wheat, it may be sown in autumn, and then it acquires the habit of later ripening, and is termed winter-barley.

Two-rowed barley is sometimes, from the colour of its corolla, black. This creates a great difference in the external appearance of the grain, but is not to be regarded as a permanent character.

The corolla of this species, as has been said, is closely attached to the grain, and forms its covering. But sometimes

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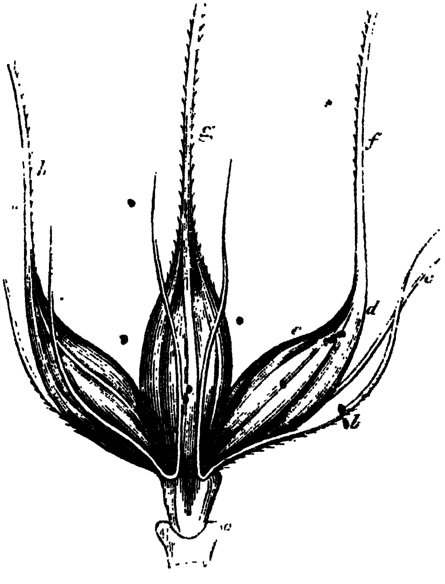
when the barley is termed two-rowed. In the following figure the three florets are represented as fertile: *a* is a joint of the rachis; *b* and *c* are the two glumes of the calyx; *e* is the inner valve of the corolla, *d* is the outer valve, of which the awn *f* is a continuation; *h* is another floret, showing the same parts; and *g* is another floret, also showing the same parts, excepting the inner valve of the corolla.



the corolla is not attached to the grain, and in this case the seed is commonly said to be naked, in which respect it resembles wheat. It is not determined whether this be a permanent character, but in the absence of proof to the contrary, it may be assumed to be so, and the naked barley held to be a species. It may be termed *Hordeum gymno-distichum.*

Two-rowed naked barley is said to have been introduced into England in the year 1768. It is now little cultivated, and is by some asserted, though without any evidence, to merge into the common species. It has been in cultivation in some parts of Europe, and has preserved its characters, for a period beyond all record.

The next species, commonly termed *Hordeum Zeocriton*, has been here termed *Hordeum disticho-zeocriton.* Two-rowed sprat or battledore barley. The spike is short and conical, the awns long and spreading, and the seeds more compressed than in the other species. As in the other species, the three contiguous florets on the spike may perfect one seed, forming two-rowed barley; or they may perfect all the seeds, forming six-rowed barley. This species is scarcely cultivated in this island, the shortness of its straw being regarded as an objection to its cultivation.

The next species is *Hordeum hexastichum*, Six-rowed barley. When sown before winter, this species acquires the habit of late ripening, and is then termed winter-barley. Winter-barley is very frequently cultivated in the countries of the north of Europe.

One of the kinds of six-rowed barley, and the best known in this country, is bere or bigg. Bigg ripens its seeds in a shorter period than the two-rowed barleys. It is cultivated in the north of Scotland, in Denmark, Sweden, and other parts o Europe. The number of its grains is greater than in the two-rowed kinds, but they do not weigh so heavy in proportion to their bulk. It is hence regarded as an inferior crop, and is only cultivated in the more elevated parts of the country. It ripens very early when sown in spring, and hence the advantages which it possesses in a late climate.

Sometimes the external cover of the grain, as in the case of the two-rowed barley, is black. This arises in either case from the change of the colour of the corolla in ripening.

The corolla of this species adheres closely to the grain, and forms its covering. Sometimes, however, as in the case of the two-rowed naked barley, the corolla is detached from the grain. Whether this be a permanent character is not determined; but, in the absence of proof to the contrary, it may be assumed to be so, in which case it must be regarded as a species. It has been termed *Hordeum gymno-hexastichum.*

The six-rowed naked barley is cultivated in various parts of Europe, and is greatly esteemed for its fertility. In some parts of Germany, it is regarded as the most valuable kind of barley, and by the French, on account of its supposed productiveness, it has been termed *orge céleste.* This, and the other superior kinds of six-rowed barley, deserves more attention than they have yet received. Almost the only kind cultivated in Britain is bere or bigg, which occupies an inferior place.

A variety of this species lately brought from Nepaul, has, in place of awns, soft hooked appendages at the termination of the valves of the corolla. These tend to disappear by the effects of acclimating in this country, and to pass into awns. This remarkable variety is cultivated in Tartary 10,000 feet above the level of the sea.

The last of the species to be mentioned is *Hordeum hexasticho-zeocriton*, Six-rowed sprat or battledore barley. This has been sometimes termed six-rowed barley: whereas the character of six-rowed does not belong to it alone. An examination of the plant will show that it is the common battledore barley, with all the florets fertile.*

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* Much confusion has arisen in the arrangement, by agriculturists, of the cultivated barleys, and in an especial degree by their speaking of four-rowed and six-rowed kinds. There is, however, no barley to which the term four-rowed can be applied. Barley is termed two-rowed or six-rowed, according to the number of its fertile florets. In two-rowed barley, one row of florets on each of the two sides of the spike is fertile, and consequently one row of seeds on each side is perfected. In six-rowed barley, three rows on each side of the spike are fertile, and consequently three rows on each side are perfected. In this sense only it is termed six-rowed barley. But there is

Thus, the species of barley which may be cultivated, are,—

1. The two-rowed species, in which the corolla adheres to the seed.

2. The two rowed species, in which the corolla does not adhere to the seed.

3. The two-rowed species of battledore barley.

4. The six-rowed species, in which the corolla adheres to the seed.

5. The six-rowed species, in which the corolla does not adhere to the seed.

6. The six-rowed species of battledore barley.

Barley, it has been said, may be sown either in spring or in autumn. It is more frequently sown in spring.

Barley is an early ripening grain, and therefore it may be sown at a late period, as the month of May; but the usual period is April, and the sooner the better. The more early that barley can be sown, the produce in grain is the surer, though the bulk of straw will be less. It may be sown at any time at which spring-wheat can be sown.

In the rotation of crops, barley may succeed to summer-fallow, to potatoes, turnips, or any other green crop, and to any of the pulse-crops.

When barley follows a summer-fallow, it is common, after ridging up the land in the manner described for wheat, to leave it in that state till spring, when it receives the seed-furrow, and when the barley is sown. It is a rule observed in the case of barley, always to sow on a freshly stirred soil. It is for this

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no species known to us in which only two rows on each side of the spike are fertile. Slightly examined, indeed, six-rowed barleys frequently present the appearance of four rows; but this is in appearance only, for such barleys have always the three rows on each side perfect. In poor soils, and unfavourable situations, two of the rows run much into each other, and this has perhaps given rise to the mistake; but the two rows which thus run into each other in appearance, are on the opposite sides of the rachis.

I have ventured to propose a new arrangement of the cultivated barleys; under which, it will be seen that the *Hordeum vulgare* of some botanists is *Hordeum hexastichum*, and that the *Hordeum hexastichum* of some botanists is *Hordeum hexasticho-zeocriton*.

reason that the seed-furrow is deferred till spring, and given when the land is dry, just before the barley is sown. The grubber might with greater advantage and economy be employed to give this spring tillage than the plough.

When barley is sown after potatoes, the land is ridged up when the potatoes are removed, generally in *October. It remains* in this state till spring, when it receives a final ploughing or seed-furrow immediately before the seeds are sown.

Barley, however, is rarely sown after summer-fallow or potatoes, because the land is then prepared for the more valuable crop, wheat. When barley, therefore, is sown in either of these cases, it may be regarded as an exception to the general rule.

Barley may be sown after beans. In this case the land, after the beans are removed, receives one or more ploughings in autumn, and is ridged up so as to remain dry. In spring it receives another ploughing, and sometimes two, immediately after which the seeds are sown. Wheat, however, is the grain which in the more general course follows beans, first, because it is the more valuable crop, and, second, because the soils suited to beans are those also suited to wheat.

When barley is sown after pease, the mode of management is the same as in the case of beans.

In the cases that have been mentioned, barley might be sown previously to winter. But the practice of sowing winter-barley is rare in this country. When from any cause, however, it is found expedient to sow barley in place of wheat after summer-fallow, potatoes, or pulse-crops, the winter-barley might in many cases be sown with advantage. In this case it will be necessary to obtain the seed of some of the winter-sown barleys in cultivation. Barley, it has been said, may be sown after turnips or other green crops, and these are precisely the kinds of crops which form the best preparative for barley. They are grown for the most part upon light soils, and the lighter soils are those to which barley is suited. These crops also are not generally removed till spring, and spring is a proper season for sowing barley. Barley, therefore, is better suited to follow such crops than wheat is. It is also generally better suited to follow them than oats, because oats are the less valuable crop. These circumstances concur in indicating that the proper place in the rotation for barley is in succession to turnips and similar crops, which remain on the ground till spring.

When barley is sown after turnips and other green-crops in spring, the land should be ploughed once, and immediately after the ploughing, the barley should be sown. But when the period of sowing is late, and the ground is hard from the effects of drought or any other cause, two ploughings are to be given to reduce the ground to a finer tilth. In this case the harrow and the roller are also employed: and the grubber is well suited for the same purpose.

When barley succeeds turnips and similar crops, which are removed before winter, or at a very early period in spring, then the land should be ploughed into ridges immediately. When the season for sowing the barley arrives, a second ploughing or seed-furrow should be given.

Barley may be sown broadcast, or in rows, giving it a single turn of the harrows after the drill-machine, and just a sufficient number of harrowings to cover the seed in the case of broadcast-sowing.

It is always found beneficial to roll this species of crop. The operation of rolling may either take place immediately after the conclusion of the process of harrowing, or after the plants are above ground. While the action of the roller compresses the soil so as to exclude drought, it comminutes it so as to afford facility to the extension of the roots of the plant. But the roller, on being employed for the covering of the grass-seeds which are sown with this crop, also effects the purpose of smoothing and consolidating the surface of the land. The time of using the roller therefore is immediately after the grass-seeds are sown.

The quantity of seeds of barley generally varies from 2½ to 3 bushels to the acre, when sown broadcast; but when sown in rows the quantity of seed need not exceed 2 bushels to the acre.

The seeds of clovers and grasses are also sown with barley as with wheat. They may be sown either at the time at which the barley is sown, or when the plants are above ground. If this is done at the same time with the barley, the seeds are sown just previous to the last turn of the harrows, and are then covered first by the last turn of the harrows, and then by the roller: or they may be sown after the land is harrowed, and covered by the roller alone. When the grass-seeds cannot be sown at the same time with the barley, then they are to be covered, when the time of sowing them arrives, by the roller alone without the harrows. When the barley is sown in rows, it may be hoed once previously to the grass-seeds being sown.

After the grass-seeds are sown, the barley-land admits of no further tillage. Should any large weeds appear, they may be pulled up by the hand, but it is the evidence of bad husbandry, if a spring-sown barley crop requires weeding during the comparatively short period in which it is on the ground.

When the period of harvest arrives, barley must be allowed to be sufficiently ripe, but not become what is termed dead-ripe. It may be cut either by the scythe or the sickle.

Barley, on account of the softness of its stem and tendency of its ears to vegetate, is more apt to be injured, and even destroyed, by wet weather than any of the other cereal grasses. For this reason the safer course in a humid climate like ours, is to place it when cut down in sheaves and shocks, and not to allow it, as is frequently practised, to lie loose upon the ground.

Barley being more subject to injury from heating, requires more precautions in the securing of it, than any other grain. By heating in the stack it quickly becomes discoloured and injured.

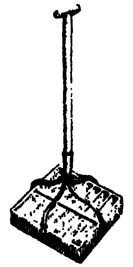
It is thrashed and prepared in the same manner as wheat; but it has this peculiarity, that the awns of the corolla adhere to the seeds, and are with some difficulty broken off, especially when the season has been unfavourable, and the seeds have ripened imperfectly.

The thrashing-machine, if sufficiently powerful, will generally break off the awns, or may be made to do so, by making the cover of the cylinder rough internally, and bringing it near to the beaters, so as to leave a small space between them and the cover. But in less powerful machines, in which the breaking off of the awns is imperfectly performed, it is a frequent practice to put the thrashed barley again through the thrashing-machine, in order that, by the further agitation which it undergoes, the awns may be broken.

Sometimes a species of machinery driven by the power which moves the thrashing-machine is applied to this purpose. It is formed upon the principle of skutching. The skutchers are arms fixed to a vertical spindle enclosed within a cylinder. There are several tiers of these arms one above the other: the barley, being put in at the top of the cylinder, is acted upon by the tiers of skutchers kept in rapid motion, and so the awns are broken off.

But when the thrashing-machine is not in use, or performs its work imperfectly, an instrument worked by the hand, termed a hummeller, is employed. This consists of a set of parallel iron plates fixed to a frame, and worked by the hand like a paver's instrument. The barley to be hummelled is laid upon the barn-floor, and by repeated strokes of the hummeller is freed from its awns.

Fig. 147



The produce of barley, like that of all grains, varies greatly with seasons, culture, and soil. A medium crop is generally held to be about 36 bushels per acre; and 40 bushels per acre are regarded as a good crop. The medium weight of two-rowed barley is about 52 lb. per bushel.

Barley is employed for various purposes. The flour is used in some parts for bread; but the bread, though sufficiently nutritious, is dark and strong-tasted.

Barley is subjected to a species of grinding, by which the external coat of the seed is rubbed off. In this state it is termed pot or pearl barley, and is employed largely in soups, gruel, and cooling drinks.

It is used in the south of Europe for the feeding of horses; but in this country the oat is regarded as the proper food of the horse. It is also employed for the feeding of hogs or other live stock. In the practice of the farm, the light or inferior barley is generally used for this purpose. This, after being boiled or steamed, furnishes a cooling and laxative food for horses and other animals.

But the great consumption of barley is for malting, to which purpose it is excellently suited.

The straw of barley is employed partially for fodder, but chiefly for litter. It is lighter than the straw of oats and wheat, and less esteemed than either. The awns of barley are given to stock, either in their natural state or boiled.

The diseases of barley are not so numerous or fatal as those of wheat. It is attacked by the larvæ of certain flies. It is also subject to smut, though in a partial degree, and the fungus is usually *Uredo segetum*.

4. OATS.

The Oat is of the genus *Avena*. The following species are those chiefly cultivated for their seeds:—

1. Avena strigosa—Bristle-pointed Oat.
2. Avena brevis—Short Oat.
3. Avena sativa—Common Oat.
4. Avena orientalis—Tartarian Oat.
5. Avena nuda—Naked Oat.

The first of these species is distinguished by the tw florets of the spikelet having each three awns, the dorsal one very long and twisted, the others short and straight. This is a native species, of inferior properties, but sometimes cultivated, as in the remoter Highlands of Scotland.

Avena brevis, Short oat, is, like the last, of inferior quality. The seeds are numerous, but small. It is cultivated in the more mountainous and central parts of France and elsewhere.

Avena sativa, Common oat, is the most important of the cultivated species. Each spikelet contains two, and sometimes three, perfect seeds. The florets are sometimes awned, and sometimes destitute of awns.

Avena orientalis, Tartarian Oat, is cultivated in England, and largely in some other parts of Europe. Its panicle is contracted and nods to a side, which distinguishes it from the last-mentioned species. The colour of its corolla is generally dark, but the plant improves by culture in a good soil, losing its awns, and that darkness of colour which appears to distinguish the oat in its less improved state.

Avena nuda, Naked oat. In the species that have been mentioned, the corolla adheres closely to the seed and forms its covering. In this species the corolla is detached from the seed, as in the case of wheat and naked barley. It is from this property that this oat has obtained the name of pilcorn or peelcorn. It has been cultivated for an unknown period in Europe, is mentioned by our earlier writers, and was once in general cultivation in Scotland, and other parts of the island. It is said to be productive, and the meal to be fine.

The oat is the natural inhabitant of colder latitudes. It degenerates in the warmer parts of the temperate zone, and in lower latitudes disappears from cultivation. It is, of all the cereal grasses, that which is the most easily cultivated, growing best indeed, as all such plants will do, on the better soils, but suited to every kind from peat to the lighter soils and clay.

Of the species that have been mentioned, greatly the most important is the common oat, *Avena sativa*. Of this species there are innumerable sorts, produced by the effects of climate, soil, and cultivation. These may be conveniently divided into three classes—the black, the dun or grey, and the white.

Those in which the corolla is very dark, are in the first class. The oats of this habit are awned, and the seeds are small. They are hardy, and ripen early, and it is this property which suits them for cultivation in cold and elevated districts. They are an inferior class of oats in their ordinary state, and should rarely be used where varieties more improved by climate and cultivation can be raised.

The next class of oats, the dun or grey, may be said to be intermediate between the black and the white. Some of them are awned and very worthless; but those that have been improved by culture and selection, are valued in the situations suited to them. Those that are chosen for seed should be plump, without awns, and with but a slight darkness of colour. The oats of this class are called red oats, sometimes dun, and sometimes blue oats.

The third class consists of those that are white, and the most improved of them are without awns. These are the least hardy kinds; but they are of the greatest weight to the bushel, and the most productive of meal.

In this class the Potato-oat is that which has possessed the greatest reputation for a time in the districts where it is cultivated. It is not so well suited to inferior soils as some of the other white and darker coloured kinds. It is less productive of straw than they, though the grain is more plump, weighs heavier, and yields a greater weight of meal. The hardier kinds, however, are better suited to certain situations than the finer, just as the hardier red wheats are better suited to certain situations than the thin-chaffed and white varieties. The potato-oat was the discovery of accident, and the produce of a single plant. It has in many cases shown a tendency to degenerate, by the husks becoming thicker and the body less plump, and by the partial appearance of awns.

Other minor varieties of the oat, which have had more or less reputation, are the Late and Early Angus, the Blainslie or Common white oat, and the Poland oat.

The varieties of the Angus oat have been much cultivated. They are hardy, of fair quality, and sufficiently productive. The Early Angus is the finer variety, and ripens about 10 days before the other.

The Blainslie oat, so named from a farm noted for producing it, used to be largely cultivated in the south-eastern counties of Scotland. It is somewhat small in the grain, but produces on good soils abundant crops of grain and straw. It is an early ripening oat, but has now generally given place to other early-ripening varieties.

The Poland oat was long greatly valued. It ripens early, and produces an abundant crop of grain; but it is somewhat deficient in straw, and is supposed to be peculiarly liable to injury from shaking. This kind has been cultivated in England above 100 years, and, during that long period, has retained its characters.

To this must be added the Dutch or Friesland oat, which is a hardier kind, or at least better adapted to inferior soils, than the Poland oat; but it has not preserved its characters so uniformly as the Poland oat.

Other kinds could be named, as having been long cultivated in this country; but those enumerated will suffice for the purpose of example. Minor varieties of this nature may be multiplied to an unlimited degree, and we may constantly expect to see new ones obtained by accident, or by care bestowed in selection. A variety which has been lately extensively cultivated is the Hopetoun oat, derived from East-Lothian. It may be said in general, with respect to the principal kinds now in use, that the Potato and other finer kinds of oat are the best suited for low lands, and the better class of soils; that the dun oats are suited to inferior soils, or to the more elevated grounds; and that on the soils lowest in the scale of fertility the improved black varieties may be used.

The oat has a wider range of soils than any of the other cerealia, and it requires, too, less preparation of the soil by tillage and manures.

The oat is generally sown after grass, and this is precisely the period in the rotation in which the oat should be sown. It grows better upon old grass-land than any other crop, and should always be sown accordingly when land is broken up from grass of some years' standing. When land, indeed, is broken up from grass of one year, wheat, it has been seen, may be sown; but, in the majority of cases, the more suitable crop is oats.

When grass-land is to be ploughed for oats, this should be done in winter, or as soon in spring as the state of the weather, and the labour of the farm, will allow, so that it may, if possible, receive a little of the winter's frost to mellow it before the oats are sown. In the ordinary practice of the farm, the first operation after harvest is ploughing the stubble-land intended for fallow and fallow crops, and then the grass-land which is intended for oats.

Oats may be sown after a summer-fallow. This is done when the soil and situation are less suited to wheat and barley than to oats. In this case, the fallow is ridged up before winter, and again receives a seed-furrow in spring, though frequently the oats are sown without the seed-furrow.

Oats are sown after pulse-crops, when the land is not in a fit state of preparation for wheat and barley, or when the soil and situation are unsuited to these crops. In this case, one ploughing is generally given in autumn, and sometimes a seed-furrow in spring.

Oats may be sown after turnips or other green crop, when they are more suited to the soil and situation than wheat and barley. In this case, the green crop being removed, the oats are sown after one ploughing.

Sometimes oats are sown after oats, or other corn-crop. This is a deviation from the general rules of good culture; but it is in some cases rendered necessary by the failure of grass-seeds, and other circumstances. In this case, the land may be ploughed once; but when grass-seeds are to be sown with the crop of oats, it is better that it receive a second tillage in spring, either by the plough or the grubber.

When land is broken up from very old grass, good farmers sometimes take two crops of corn in succession. This is a deviation from the rules of the alternate husbandry. Circumstances may render it expedient; but it is the exception, and not the rule of general management.

Grass-seeds may be sown in spring with oats, in the same manner as with wheat and barley. But the land should in this case be prepared by previous fallow or green crop.

Oats are, for the most part, sown broadcast. When land is broken up from grass, the land is not in so good a state for allowing the drill machine to operate, and accordingly the more suitable method of sowing is broadcast. Exceptions to this may be required, when there is a great prevalence of annual weeds,—as of the wild radish and wild mustard; but the general rule for sowing oats is broadcast, and the sowing in rows the exception.

The period of sowing oats is generally from the beginning of March to the end of April. From the beginning to the middle of March is held to be the best period, when the weather and state of the ground will allow.

The quantity of seeds sown may be from 4 to 6 bushels to the acre. There are rarely sown more than 6 bushels, and there ought never to be sown less than 4.

Oats, from being sown after grass-land, are more apt to be overrun with thistles than the other kinds of grain: hence it is usual to weed this crop by going over it with the weeding instrument before referred to.

The reaping of oats is by the scythe or sickle, in the manner before explained. They should be allowed to ripen, but not to stand till they are dead-ripe. When ripe, they are to be taken sharp, as it is termed, by which means the chance of loss by winds at this critical period is lessened.

The produce of oats varies greatly with the nature of the soil and the mode of management. It is frequently calculated that 30 bushels to the acre may be the average of this country. In Scotland, where the culture of the oat is more attended to than in any other part of Europe, 60 bushels are held to be a great crop, below 25 an indifferent or bad one.

Oats vary in weight from 35 lb. to 45 lb. the bushel. The produce in flour is generally regarded as in the proportion of about 8 to 14; that is, 14 lb. of grain give 8 lb. of meal, though the proportional quantity of meal increases as the oats are heavier.

The meal of the oat is used for bread; but though it is the food of a great part of the inhabitants of the north of Europe, it is inferior for this purpose to the flour of rye, and greatly inferior to that of wheat. It is used, however, in various simple preparations for food.

But the principal consumption of the oat is for the feeding of horses, to which purpose it is eminently adapted. In the practice of the farm, it is common to reserve the light corn for the feeding of the horses, and the heavier grain for seed and for sale.

The oat is employed also in malting and distillation; but for these purposes it is inferior to barley.

The straw of the oat is, in this country, more esteemed for provender than that of wheat, barley, and rye. It furnishes a great part of the food of wintering cattle, as will afterwards be explained. It is given also to working horses in place of hay in the early part of winter, when the work is not severe.

Oats are subject to considerable hazard of injury by the shaking of winds, as the grain approaches to its ripened state. In the early stages of its growth, too, it is subject to be attacked by several enemies, of which the principal is the wireworm, which is the larva of a very small beetle, *Elater segetis*; and by the larvæ of several other insects, comprehended by farmers under the general name of grub.

The diseases of the oat are not numerous. It is subject, though in a partial degree, to smut, occasioned by *Uredo segetum*.

5. Millet.

Under the term Millet are comprehended certain plants of different genera, which are cultivated for their seeds:—

1. Panicum miliaceum—Common Millet.
2. Setaria italica—Italian Setaria.
3. Setaria germanica—German Setaria.
4. Sorghum vulgare—Indian Millet.

Common millet grows several feet high, and is terminated by a large branched panicle hanging to one side. It is very prolific in seeds. These are small and smooth; in some sorts brown, and in others yellow. The plant is cultivated extensively in Russia, in Italy, and Germany. Its seeds, being divested of their outer covering, are used in the manner of rice, and furnish a nourishing and grateful food. They are also made into bread, which, however, is not esteemed. They are used for the feeding of domestic fowls, for which they are well suited. The straw produced is bulky, and valued for provender.

The cultivation of common millet is not practised in this country. It is not with us a part of the food of the people, while with respect to the feeding of domestic fowls, we have so many resources in the waste of our cereal grains, that there is scarcely need of cultivating any plant expressly for the purpose. But more than this, millet is not well suited to the colder parts of Europe, and supplies of it can be obtained in unlimited abundance from the shores of the Mediterranean.

The Italian setaria, cultivated in the south of Europe, is only known to us in this country as a plant of the garden. It is too delicate for the northern parts of Europe: for even about Bordeaux it is a precarious crop, suffering frequently from the effects of frost.

German setaria is cultivated in Hungary in fertile subhumid soils. It is used in its green state, or as dried fodder for horses and oxen.

The Indian millet furnishes bread to the Arabians and other people of the East. The flour is known to the Arabs under the name of dourra; and it is truly the bread-corn of Africa, being grown over all the parts of that vast continent. It is cultivated likewise in Italy and the south of Germany: and it was long ago introduced into Spain, it may be supposed by the Moors, if not at an earlier period still by the Carthaginians. It has been introduced also into the Islands of the West Indies, under the name of Guinea corn, and into the Southern United States of America.

This fine plant grows with a strong reedy stem, with broad leaves like those of the maize, but smaller, and producing a large panicle. Its seeds are smooth and roundish, resembling those of the common millet, but larger. They are ground into flour, but the bread made of it is dark in colour and coarse. In Europe, the grain is chiefly used for feeding domestic fowls and pigeons, for which it is well suited.

This plant is the native of a warmer country, and demands a more genial climate than we possess. With us it will scarcely even ripen its seeds, and frequently not even expand its flowers. Other species of *Sorghum* are likewise cultivated, but the same remark applies with more or less force to them all.

6. MAIZE.

Of the cultivated Maize, *Zea Maïs*, the varieties produced by differences of climate, and other external causes, are very numerous, differing greatly from one another in size, aspect, and the period of maturing their seeds.

The maize has a wide range of temperature. In the western continent, it flourishes from about the 40° of southern to beyond the 45° of northern latitude. It is extensively produced in Africa, Asia, and the South of Europe. On all the shores of the Mediterranean,—Spain, Italy, and the countries of the Levant,—it supplies the food in most common use. The region of the maize in Europe seems to have been extending northwards. It is grown in France. Germany, and even in the Netherlands. The last, however, is somewhat beyond the true region of the maize, which requires the warmer summer of the south of Europe to bring it to its full perfection. The kinds best suited to the colder parts are the dwarf, some of which, even in the latitude of Paris, complete the circle of their vegetation in a period comparatively short.

The manner of cultivating the maize in the countries where it is produced, is generally rude and inartificial. The proper method of cultivating it is in rows, at the distance from one another of from 3 to 4 feet. In this manner the plants can be tilled by the horse and hand hoe in the most perfect manner, and the earth heaped up to the stems of the plant by the operation of the common plough. This heaping up of the earth tends to support the long stem and weighty ears. The plant, although it has a very fibrous root, does not penetrate deep into the ground; but from the lower joints of the stem, it sends forth large roots, which partly serve the purpose of supporting it. During the growth of the plant, and even till the seeds are formed, the tilling may be continued, and the earth heaped up to the stem.

The maize is a plant which with difficulty bears the rigour of early spring. It is easily injured by frosts; and hence the necessity of adapting the period of sowing it to the peculiarity of the climate. The plant, like the other gramineæ, may be transplanted, and that, too, after it has attained a considerable size. In planting, therefore, it is well to have a provision of plants for the filling up of blanks.

A peculiarity in the manner of treating the plant is founded upon the circumstance of its being monœcious. The flowers bearing stamens are produced in a branched spike at the summit of the stem. The female flowers grow lower down on the stem. Upon these the pollen falls from the flowers above. As soon as the male flowers have performed their functions by depositing their pollen on the organs below, they become no longer necessary, and they accordingly, with all the elevated part of the stem which supports them, may be removed. This is familiarly termed topping; and the period of performing it is denoted by the state of forwardness of the plant. When the silk-like filaments of the female flowers are withered, and when, upon stripping off the husks, the grain is found to be somewhat hardened, then the tops and even the leaves may be removed without injury. These form a valuable deposit for the winter, and may be reserved for food for horses and oxen in spring.

The harvest-labours of the maize are altogether different from those of the other cerealia. The ears are stript from the stem by the hand, and carried directly to the barn-floor to undergo the process of husking. The husks, consisting of a thick leafy covering which closely envelopes the ear, are then also stript off, and the ears are deposited in some convenient place.

The next operation is that of separating the grain from the ear. This may be done by a machine, but it is generally done by scraping or rasping the ears upon a piece of iron fixed across a wooden vessel into which the grains are received.

The flour of the maize, on account of the deficiency of gluten, is greatly inferior to the flour of wheat for the making of bread. It is, however, a perfectly nutritious substance, and becomes palatable to those who are used to it. Its flour is converted into various preparations, and used extensively in the countries where it is produced. In America the people of every condition eat the maize in its different states. The most delicate perhaps is when the ears are green, and the seeds simply roasted or boiled. In this state they are enjoyed by people of all ages throughout the United States.

The maize is a nourishing food for all the domestic animals. It is suited to the feeding of the horse: hogs get speedily fat upon it, and poultry eagerly eat the hard grains.

The maize is thus a very valuable plant in all the countries in which it is produced. It is only, however, in the warmer parts of Europe, or in the countries which, like North America, have a hot summer, that the maize is calculated to take the place of the common cerealia.

7. RICE.

Rice has been known and cultivated from the earliest records of the human race, and is believed to furnish food to a greater number of human beings than any other of the cultivated gramineæ.

Of this plant there is held to be but one species:—

Oryza sativa—Common Rice.

But there are subspecies, or varieties, so greatly different in their habits and characters, that they may be rather regarded as specifically distinct. The common rice grows from one to six feet in height, terminating in a panicle. The seeds are armed with awns. It is cultivated in marshes, and for a great part of its growth, is partially under water. The mountain rice grows on mountains and dry soils. The plant has been recently found growing high on the range of the *Himalayan* mountains.

The rice is spread over all the warmer regions of the Old World, and has been carried to the New, where it flourishes in great luxuriance. It is cultivated in the south of Europe, and has lately been extended to the more northern parts of it,—to Westphalia, and even to the Low Countries. It seems to be a plant fitted, in a remarkable degree, to accommodate itself to different situations. The range of its vegetation has extended northwards. It is a considerable period since it was introduced into the countries north of the Mediterranean,—Greece, Italy, and Spain. It is more recently that it has extended to Hungary and central Europe; but whatever be the power of acclimating of the rice, there is little reason to suppose that it will ever form any thing beyond an inconsiderable part of the cultivated gramineæ of Europe.

Canary-Grass, &c.

The cereal grasses that have been enumerated, afford the main part of the farinaceous food of mankind. Besides these, however, other grasses are cultivated, or used for their seeds, as—

1. Phalaris canariensis—Cultivated Canary-grass.
2. Poa fluitans—Floating Meadow-grass.
3. Digitaria sanguinalis—Hairy Cocksfoot, or Finger-grass.

Canary-grass is cultivated in a few parts of the south of England, and chiefly in the Isle of Thanet, for its seeds, which are given to the smaller birds. The plant is easily raised, but is of little economical importance.

Floating meadow-grass is a native plant tolerably productive of seeds, which are sweet and nourishing. They are collected in some parts of Germany, Poland, and other parts of Europe, and used as food; and they are brought to this country under the name of Manna. The plant is too aquatic in its habits to admit of extended cultivation.

Hairy Cocksfoot, or Finger-grass, is an annual plant, growing in sandy cultivated fields. In Poland and Lithuania it abounds by the road-sides, and its seeds, being collected and boiled with milk in the manner of rice, are said to be esteemed.

Many other grasses could be enumerated as yielding seeds of sufficient size to be used as food ; but none of them can be regarded as fitting subjects of cultivation for their seeds.

II. *LEGUMINOUS PLANTS.*

1. THE BEAN.

The bean is of the genus *Faba*, of which there is reckoned one species—

Faba vulgaris—Common Bean.

But great diversities, in the habit and aspect of the plant, have been produced by the effects of climate, soil, and culture.

Of the beans which form the subjects of cultivation in this country, there may be said to be, with respect to their uses, two general classes,—those which are cultivated in the fields, and are thence termed field-beans, and those which are cultivated in gardens, and so termed garden-beans. The former, too, are frequently termed grey beans, and the latter white beans.

Of the white or garden beans, the sorts are very numerous. Those that may be here referred to as cultivated also in the fields, are the Mazagan-bean and the Long-podded.

The Mazagan-beans are regarded as the best of the early kinds at present in cultivation. They are said to be derived from Africa; and their habits change by their being cultivated in this country. They become larger, and do not ripen so soon as when first imported.

The Long-podded are of the middle size of garden-beans, and are very productive, the pods being long, and closely filled with seeds. Of the long-pods there are many varieties enumerated by gardeners.

These two sorts, though raised in the garden, are also cultivated partially in the fields, and they are reckoned to be the best of the garden kinds used for this purpose.

The kinds, however, the most important to the agriculturist, and forming the subjects of common cultivation in the fields, are the small or hardier kinds, termed the field-beans. Of these, the principal are the horse-bean and the tick-bean. The former is the more hardy; the latter is generally regarded as of better quality, and more productive. The horse-bean grows more tall than the tick-bean, but is not so productive of pods. The tick-bean contains many subordinate varieties, to which names are assigned, as the Flat-ticks or May-beans, the small or Essex-ticks. To the field-beans in use may be added the Heligoland bean.

The bean, generally speaking, is suited to the stiffer clays. The seeds may be buried deeply in the ground. In colder countries, they are generally sown in spring: but they may be sown previous to winter, and then the beans acquire the habit of later ripening, and are termed winter-beans. The manner of cultivating the bean is greatly influenced by climate; and the agriculturists of different countries learn to suit their practice to this circumstance.

The bean, like all other plants cultivated for their seeds, is an exhausting crop; but then, from the habit of its growth, and the mode of cultivation which it admits of, it is a cleaning crop, and, in the rotation, is generally made preparatory to a corn-crop. It is regarded as well suited to prepare the land for wheat or barley: and ought, therefore, to precede one of these crops.

Beans may be sown on land broken up from grass, and will succeed perfectly well in such a case; but this is not the true place in the rotation of the bean: for oats are more generally suited to land broken up from grass; and beans should rather follow a corn-crop.

When the bean is to be sown in spring after a corn-crop, the land should receive a deep ploughing before winter, generally in the direction of the former ridges, so as to keep the land dry. Sometimes, in case of dry land, the ploughing may be across the ridges; and then the plough, passing along the former open furrows, is to form new open furrows in the same place. In either case, care is to be taken to prevent the stagnating of water on any part of the surface.

As early in spring as the land is sufficiently dry to be worked, it is to be ploughed across the direction of the former ploughing. The land is now to be left to dry for a few days, and then it is to be harrowed, so that the surface may be levelled; and then, with the common plough, the whole surface is to be formed into raised ridglets, or drills.

These drills are formed by a single furrow or turn of the plough in the following manner:—The plough, entering at the headland of the field, at *x* in the diagram below, draws the straight furrow *x y* from side to side. Turning to the right at *y*, and entering at *z*, it draws the straight furrow *z r*, and thus forms the drill *x y z r*, of which the centre is AB; this first drill being necessarily formed by a double turn of the plough, while the others are formed by single turns; for the plough, then turning to the right and passing on to E, draws the straight furrow EF, and so forms a drill by a single turn. At F it turns to the right, and, passing on to G, draws the straight furrow GH, and so forms another drill; and then, passing to I, and drawing the furrow IK, forms another drill; and so on until it has formed a certain space into drills. Equal spaces being drilled in this manner, the whole field is passed over. The plough, it has been said, is to turn to the right, but it may be also turned to the left if more convenient: or, having formed a certain space into drills by being turned to the right, it may form an intermediate space into drills, by being turned to the left, on the same principle as was explained in the case of cross-ploughing. In place of forming the first drill by a

Fig. 148.

double turn, in the manner described, the operation may be performed thus: The plough passing from *x* to *y*, forms the drill *x y z r* by a single turn. On arriving at *y*, the plough turns left about, and, returning by the same track, forms another drill *yx* EF, also by a single turn; on arriving again at *x*, it turns to the left, and proceeding from *r* to *z*, forms the drill *rz* GH; on arriving at *z*, it passes on to F, and proceeding from F to E, forms the drill FEIR.

The drills thus formed should not be less than 27 inches from centre to centre. A transverse section of the land, when drilled, will appear thus:—

The land being thus ridged up, the seeds are to be sown by the sowing-machine (Fig. 32), or better by the machine Fig. 33, which sows three rows at once. The former is pushed forward by the workman, the latter is drawn by a horse. The seeds are thus sown in the hollows of the drills, and the plough passing along the centre of each drill, splits it into two, and so covers the seeds. The common plough performs this operation, or it may be performed by a double mould-board plough. A transverse section of the drills when split or divided will appear thus:—

In this manner, the seeds are well covered, sown in rows at the distance required, and prepared for the subsequent operations.

But the previous operations taking place at a very early period of the season, wet weather may intervene to prevent this species of tillage. In this case, in place of first ploughing the land, and then forming it into drills, it may be found necessary to give only one ploughing. The simple sowing-machine, pushed along by the hand, is to follow every third plough, or, in other words, to be pushed along every third furrow, depositing the seeds in the hollow. The succeeding furrow-slice covers the seeds, and thus they are deposited and covered in every third furrow throughout the field. By these means the seeds are sown in rows; and, supposing the width of each furrow-slice to be 9 inches, the distance in the rows of beans from one another will be 27 inches; or 30 inches, supposing each furrow-slice to be 10 inches.

The latter method of sowing is less effectual than that by raised drills, and therefore should not be resorted to, except when the state of the weather renders it necessary.

The running of a sowing-machine in every third furrow may seem to be a somewhat clumsy operation; and yet the loss of labour is extremely trifling. Some farmers, however, attach the sowing-machine to every third plough, fixing it between the handles in such a manner that it sows the seeds in the furrow which is just formed; the three ploughs following one another in succession, and the third sowing the seeds, these are deposited and covered in every third furrow.

Dung is often to be applied to the bean crop, especially when wheat is to succeed; and it may be applied at two periods. It may either be spread upon the stubble in autumn, or it may be applied at the same time at which the drills are formed.

In the first case, the dung, being spread upon the stubble, is covered by the ploughing which is then given: and this is greatly the better practice. In the second case, the land being formed into drills, and the seeds sown in the manner described, the dung is to be carried to the rows in single-horse carts, the horse walking in the interval of every third or fifth drill. The dung is to be dragged out by the dung-drag (Fig. 81), from the cart behind into little heaps. Three or more young persons are to follow each cart, and to spread out the heaps regularly. The dung is in this manner spread over the seeds. The ridglets are then to be split in the manner before described, and in this way, the dung and seeds covered. Some prefer spreading the dung first, and then sowing upon it the seeds.

When no drills, however, are formed, and when the seeds are sown in every third furrow, then the dung, if it has not been applied in the preceding autumn, is merely spread upon the ground before the land is ploughed, and covered by the plough at the time of sowing.

Such is a simple method of performing the culture of the bean, which has been found to be efficient in parts of the country where, from the uncertainty of the climate, and the nature of the soil, the culture of the bean is the most difficult. This system, then, of sowing the bean in rows and in drills, is susceptible of being every where practised, and from its efficiency and simplicity, deserves to be generally imitated.

In various parts of England, a more operose method is adopted of sowing the bean. The land is not ploughed until about Christmas, or as soon afterwards as possible; and upon the furrow-slice turned up, the seeds of the bean are planted by means of the dibble, in regular lines, at the distance from one another in the rows of two or three inches, and at the rate per acre of about two bushels. The practices, however, which prevail in different parts of England, both with respect to the method of sowing, the quantity of seeds used, and the general treatment of the plant, are very various.

The bean being a slowly ripening plant, the period of sowing should be as early after the land can be prepared in spring as possible. The month of February should be selected if circumstances will allow, and the sowing should not be later in any case than the month of March.

Beans may be sown previous to winter, though the practice is not suited to a very cold and humid climate. Where this system is adopted, the produce of beans sown before winter, or winter-beans, as they are called, must be selected, and those always of the hardy kinds. When the bean can be sown previous to the months of winter, it removes certain difficulties attending the present method of cultivating it, and hastens the harvest process, so often injuriously retarded in the case of cold countries.

The quantity of seeds sown must depend upon the nature of the soil and climate. In the north of England and Scotland, four bushels to the acre are not found to be too much; while in the parts of England where the climate is more favourable to the ripening of the bean, a much smaller quantity is used, and especially where the dibbling process is resorted to.

It is a frequent practice to mix a quantity of pease with beans, generally in the proportion of about half a bushel to the acre. This increases the value of the fodder, and generally adds to the weight of the crop. But many farmers do not approve of any intermixture with the bean.

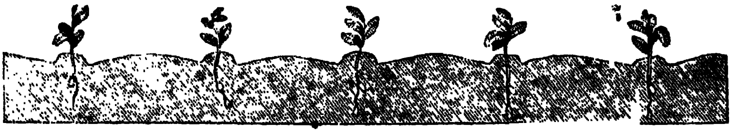
In about ten or twelve days after the beans have been sown, the land is to be well harrowed across. This process of harrowing should be resorted to in all cases of the bean culture, whether the beans are sown in drills or on a flat surface. It should be performed just before the beans appear above ground; or, if it cannot be then done, it may be delayed till after the plants have got a little above ground. This operation of harrowing destroys the weeds that may be springing up amongst the plants, or in the intervals of the rows. It seems to be a very rude process, and yet it is never hurtful, but, as in all cases of stirring the soil, tends to promote the vegetation of the plants.

Immediately after this harrowing process, care must be taken to clear out all cross channels, so as to give free egress to surface-water; nothing being more destructive to a crop of beans at this stage of their growth, than to permit water to stagnate upon the field.

After the beans have made some growth, sooner or later, according to the state of the weather, the process of horse-hoeing is to commence.

The hoes employed for this purpose are either the small single-horse plough (Fig. 36), or the horse-hoe, with coulters (Fig. 37, 39, or 40). In the first hoeing to be given to the plants, it is frequently better to employ the single-horse plough. The subsequent hoeings may be done by the horse-hoe. When the plough is used, the ploughman, driving his horse between the rows, makes a shallow furrow as near the rows of the plants as the plough can go without injuring them, laying the furrow-slice towards the centre of the interval. He then returns by the adjoining row, in the same manner, throwing the furrow-slice also towards the centre of the interval; and in this way the ground is tilled as near the rows of plants as the plough can go. A transverse section of the drills after this operation will appear thus:—

Fig. 151.

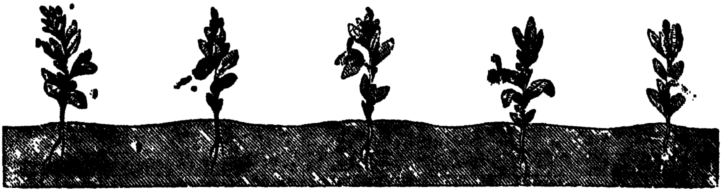


Immediately following the operation of the horse-hoe, the hand-hoers, each with a little hoe (Fig. 79), are set to work. Each hoer takes a row, and with the hoe cuts up any weeds that may have escaped the action of the hoeing instruments, or that may be found amongst the plants in the rows, using the hand when necessary to pull up weeds amongst the plants.

In about a fortnight after this, the horse-hoe again passes along the intervals, and again the hand-hoers follow, cutting or pulling up all the weeds that may have escaped the action of the horse-hoe.

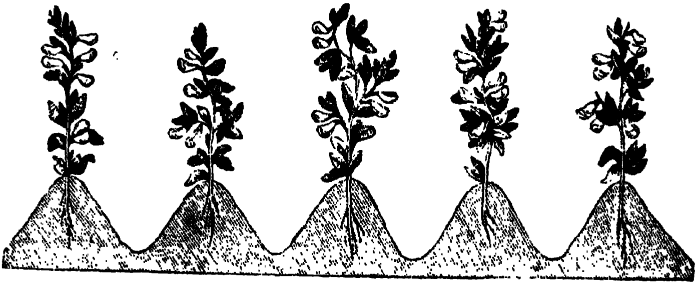
This will generally complete the hoeing process; but, if necessary, the hand-hoers are to be set to work a third time, so as effectually to clear the ground of all remaining weeds. A section of the ground after these operations will appear thus:—

Fig. 152



Some time after the last hoeing, the double mould board plough (Fig. 38) may be driven along the centre of the intervals, so as to lay up the earth as close to the rows of plants as possible. Many farmers, however, omit this final ridging up of the land, either conceiving that it is unnecessary, or that it tends to interrupt the harvest process, by rendering the ground uneven. Yet this final ridging up makes a good conclusion to the process of culture. A section of the field, after this operation, will appear thus:—

Fig. 153.



The cleaning processes being performed, the plants grow without further care, and will generally cover all the surface, and prevent the growth of weeds during the remainder of the season.

A well managed bean-field cultivated in this manner will be like a garden. The land, in respect of cleanness, will be nothing short of the condition in which it would be after a summer fallow, and the soil will be prepared for a crop of any of the cereal grasses.

The superiority of the practice of drilling over that of sowing broadcast is apparent. In the case of broadcast, a favourable season, and other circumstances, may cause as great a crop to be produced, but this will not be so upon an average of seasons, while all the advantages of the more perfect tillage of the ground will be lost.

In all cases of the row-culture, the system should be carried into full effect. The intervals between the rows of plants should never be made narrow, with the design of saving ground. All

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In cold and humid countries, the harvest-management of the bean is peculiarly difficult, on account of its late period of ripening, and the large and succulent stems of the plant.

The bean should be suffered to ripen itself thoroughly, but not to become over-ripe. The period of ripening will be denoted by the skin of the seeds having acquired a yellowish leather-like appearance.

Beans may be cut by the scythe or by the sickle. When the sickle is used, the utmost care is to be taken that the plants be cut low, both on account of the value of the straw, and of the saving of such pods as may be growing near the bottom of the stem. The beans are to be formed into sheaves, by tying them with straw-ropes previously prepared, or, when pease are mixed with beans, by ropes formed of the stems of the pease twisted upon the spot at the time of reaping. The beans should be merely laid upon these ropes in the first place, and left for a few days to dry and wither, before they are bound into sheaves. Some lay down the beans, in the first place, in large handfuls, upon the ground, and allow them to remain there for a few days, before being collected and bound into sheaves. When the sheaves are bound, they are to be set up into double-rowed shocks, without any covering of head-sheaves.

The beans, when fully ready, are carried to the barn-yard, and formed into stacks like other crops.

They are thrashed and dressed in the manner described in the case of the cereal grains. From the largeness of the seeds, the process is a simple one, the lighter and broken grains being more easily separated from the heavier than in the lighter kinds of corn.

The produce of the bean is exceedingly various in this island. Forty bushels to the acre are regarded as a great crop; 30 bushels are a satisfactory one, and probably the average produce of the kingdom does not amount to 24.

The grain of the bean is chiefly applied to the feeding of horses, though largely also to that of other domestic animals, and chiefly of hogs, in which latter case it is usually manufactured into a coarser kind of meal. In the feeding of horses, it is common to mix a portion of beans with oats.

The straw of the bean is nutritious and wholesome. It is generally given to horses, and is reckoned little inferior to hay.

The bean is a plant very subject to diseases, and, in an especial manner, to injury from the attacks of several animals.

The most common disease of the bean is a species of rust, produced by parasitic plants of the mushroom family, growing upon it in the same manner as rust or mill-dew on wheat.

The animals that attack and feed upon the juices of the bean are certain aphides, the most common of which is of a bluish-black colour, and is called the *collier*. In some seasons this creature is very destructive. It begins at the top of the plant and continues multiplying downwards. A remedy, which has been suggested and practised, is to cut off the top of the plants as soon as the aphides appear; and this may be a palliative if carefully performed.

2. The Pea.

Of the cultivated Pea there seems to be one species, comprehending our various cultivated kinds, whether grown in the garden or the field, namely—

Pisum sativum—Cultivated Pea.

But botanists of high authority make two species, *Pisum arvense*, the Grey Pea, and *Pisum sativum*, the Cultivated pea of the gardens.

The changes produced in this plant by the effects of climate, soil, and culture, are very great. Whether regarded as one or two species, pease, with respect to their uses, may be divided into two classes; the first, the field pease of different colours, and the second, the white or garden pease. The coloured kinds are those which generally form the objects of cultivation in the fields; the white kinds are those which are grown in the garden, though several of the white kinds are also cultivated in the fields, and though some of the garden kinds are coloured.

The garden pease are distinguished by their periods of ripening and other properties. New kinds of them are raised every year, and generally receive names from the persons who have first cultivated them, or the places where they have been grown. Their characters, however, are not permanent, and they degenerate, unless cultivated and selected with care.

The field kinds are distinguished by their habits of ripening. The early-ripening kinds admit of being sown late; the late-ripening kinds must be sown early. The common early-sown pease of this country are small and dark in their colour. The most hardy of these is generally termed the early grey pea. It is chiefly cultivated for the food of horses.

The later sown kinds of field pease are larger in their size, and approach more in their characters to the garden pease The seeds are of various colours, blue, speckled, grey, and dun; and they have purple flowers, whereas the true garden kinds have generally white flowers.

The white kinds usually cultivated in the fields in this country are the Pearl, the Early Charlton or Golden Hotspur, and the common White or Suffolk. Of these the early charlton has been long esteemed as an early-ripening kind.

The pease of this class are largely cultivated in the north of Germany, in Poland, and all over the central and southern parts of Europe. In England they are raised to a considerable extent in Middlesex, Kent, Suffolk, and some other counties. But the principal cultivation of pease in this country is of the grey or field kinds.

Sometimes pease are cultivated to be used in their green state. There is no species of cultivation more profitable than this, where it can be adopted; for the pease being ready for use in the month of June, time is allowed for taking another crop, generally of turnips, in the same season. The practice, however, of gathering pease in their green state must necessarily be limited to the vicinity of great markets; and in most parts of the country it is the province of the gardener rather than of the agriculturist.

The general purpose in cultivating the pea is for its ripened seeds. When these are intended for boiling, the white kinds are used; when for the food of horses and other animals, the grey kinds are preferred. The method of cultivating either kind is the same. The circumstances to be chiefly attended to is the habit of ripening, which should determine the period of sowing.

The later-ripening kinds are sown in February or March; the earlier-ripening kinds in April, and sometimes so late as the beginning of May. But the more early all kinds of pease are sown the better.

The pea will grow on stiff soils as well as the bean; but it is more peculiarly adapted to the lighter class of soils, and in an especial degree to the calcareous.

The pea, like the bean, may succeed to any of the corn-crops; and, if properly tilled, it may, like the bean, be regarded as a cleaning-crop, and be succeeded by another corn-crop.

In many parts of England the pea is made to succeed to a crop of grass and clover, and it will grow well under such circumstances; but it has been before observed that a corn-crop may then be taken with benefit. It is generally better, then, that a crop of oats be taken, to which may succeed a crop of pease. This at least is the rule of practice, while the deviation from it which particular circumstances require may be regarded as the exception.

In the case of sowing pease on land broken up from grass, it is common in some parts of England to plant them by means of the dibble; and the most approved method of doing so is to put a row of holes upon each sod, so that the rows shall be at the distance from one another of about 9 inches. To allow of this the furrow-slices are laid very flat.

When the pea, however, is to follow a corn-crop, which is its proper place in the rotation, the land is ploughed before winter as for beans, though there is not the same necessity for giving a very deep ploughing, as in the case of the ean, the root of the pea being more fibrous, and not striking down in the same degree into the soil.

When the land is ready to be worked in spring, it is to be cross-ploughed and well harrowed; and the pease are to be sown in rows, at the distance from one another of about 27 inches. Several methods of sowing may be adopted:—

1. The land, after being pulverized by the cross-ploughing and harrowing, may be sown with the same kind of drill sowing-machine as is employed for the common grains.

2. The land may be formed into drills, as in the case of the bean; and the sowing-machines, Figs. 32 or 33, employed to sow the seeds. The land is next to be harrowed across, and thus the seeds are covered. It is not necessary to split the drills by the plough, as in the case of the bean. The harrow does the work equally well, covering the seeds of the pea to the depth of 2 inches, which is sufficient.

3. The seeds are sometimes covered by the plough, in which case they are sown in every third furrow. But the more frequent practice is to sow in every furrow, in which case the rows are only 9 or 10 inches asunder. This is a species of drilling certainly, but the great advantages of the drilling-system are lost when the intervals are thus narrow.

Of these methods of sowing the pease, the best, it is conceived, is that of sowing them on a flat surface by the common corn drill-machine, the orifices being adapted to the larger size of the seeds.

When either system of culture is practised, the quantity of seeds may be 3 bushels to the acre, or less.

When the plants are a few inches above ground, the horse-hoe with lateral coulters (Fig. 37.) is to pass along the intervals, the coulters being set to go as near the rows of plants as possible without injuring them.

Soon after, the hand-hoers, with the hoe (Fig. 79.) follow, and hoe up any weeds that are amongst the rows of plants, or that may have escaped the action of the horse-hoe in the intervals.

Then, before the plants come into flower, the hand-hoers are again to pass along the rows, and hoe up all weeds as before. This completes the culture of the pea, which will now grow with great rapidity, and soon cover the intervals. Sometimes this growth is so considerable, that only one hoeing can be given; but in every case one horse-hoeing in the early stage of the plant, and one hand-hoeing, must be given.

When the intervals, however, are very narrow, as 8 or 9 inches, the common horse-hoe cannot be applied, and the hand-hoe alone is used. In some cases, indeed, particular kinds of horse-hoes with flat triangular shares are employed.

Early hoeing in the case of this plant should never be neglected. The effect is not only to repress the growth of weeds until the plant shall have acquired sufficient strength, but, as in all cases of tilling the ground about the stems, to give increased vigour to the growth of the plants. From the manner of growth of the pea, and from its stems quickly stretching over the intervals of the rows, the process of hoeing should be begun early, and assiduously prosecuted. After the first crops of weeds are destroyed, the plants themselves will grow and stifle all that may spring up during the subsequent period of their growth.

This is the system under which the pea may be beneficially cultivated. The land will thus be cleaned in an efficient manner, and prepared for any crops of grain that are to follow.

With the early-sown varieties of pease, it is common to sow a proportion of beans. This is a good practice, the tall and erect stems of the bean affording a support to the other, in the same manner as branches do in a garden. The proportion of beans may be equal to one-fourth part.

When manure is applied to the pea-crop, it should be laid on the ground and covered by the plough before winter rather than in spring, fresh manure tending to cause this plant to run too much to straw. Lime is extremely beneficial in the case of this crop.

The ordinary method of harvest management for the pea differs from that of the other kinds of grain mentioned. In some parts there is employed a tool called a pease-make, which is merely the half of an old scythe fixed in a handle. With this the pease are cut and rolled up into what are called wads or wisps, in which they are left to dry. In other cases, old blunt hooks are employed, by pulling which towards the reaper the plant is torn and broken at the surface rather than cut. The binders move in advance of the reapers, twisting the ropes for binding, and laying them down. The reapers, as they advance, throw the ropes behind them, and lay upon them the reaped pease in moderate bunches, *their heads all in one direction*. In this state they lie for a few days to wither, and are then tied in sheaves, but they are not set up in shocks. They are left upon the ground to dry until they are ready to be carried home and stacked, and in the mean time they are to be turned once a-day, which is easily done by boys or girls passing along the rows with hooks in their hands, and hooking over the bunches.

The produce of the pea is very uncertain. Perhaps none of our cultivated crops presents such frequent failures. This arises partly from the diseases to which the plant is subject, and partly from the effects of late ripening and unfavourable weather. Thirty bushels per acre are held to be a good crop in most districts of this country. Perhaps the average of the kingdom should not be stated as exceeding 20 bushels per acre.

Pease are much employed in this country as the food of horses, and for this purpose they are generally mixed with oats. They form a very nutritious food, and should be given when dry, and in all cases bruised. They are also employed for the feeding of hogs in the same manner as beans are, and they form a nutritive and fattening food. In this respect they are held to be superior to beans, which feeders imagine give a hardness to the pork. The meal, too, as well as that of beans, is made into a thick gruel, which, given with milk, forms an exceeding good food for calves, after they have been fed for some time on milk.

But the pea is also used extensively for human food. In some cases it is ground into meal, and made into bread; which, however, though nutritious, is coarse and unpalatable. But the meal of the pea may be m[illegible] to a considerable extent with the flour of wheat, without sens[illegible] impairing the qualities of the latter. It is made also into b[illegible]ith the flour and meal of barley.

But the most common application of the produce of the pea is for soups, puddings, and other articles of domestic economy. In this way there is a great consumption of the pea in England, partly the produce of the country and partly derived from the Continent. And a distinction is made between the different kinds of pease, derived from the difficulty or facility of boiling them. Those that moulder down are technically termed boilers, and this property seems to arise less from the particular variety, than from the nature of the soil in which they are produced. Calcareous matter, so favourable to the growth of the plant, tends, it is said, to give the quality of hardness to the seed. To fit the pea for its culinary preparations, the seeds are subjected to a species of grinding, by which the external covering is rubbed off.

The straw of this plant is greatly esteemed for fodder. It is not regarded as much inferior to hay, and it is given in place of hay to the working cattle of the farm. Sheep too are fond of it, and it may be given to them in the cases where hay would otherwise be given.

The pea, like the bean, is subject to various diseases. It suffers like the bean from rust, and is rather more subject to injury from insects at the root. It is liable too, like the bean, to the ravages of aphides. At a late period of its growth, great injury is sometimes sustained by a small beetle, *Bruchus granarius*, which deposites its eggs in the pods, and the grubs of which destroy the seeds. Other species of beetles, in different countries, prove fatal to the pea; and in some countries to so great an extent has this taken place, as to put a stop to the cultivation of the plant. Assiduous tillage, and the avoiding of too frequent repetition of the crop, are the best preservatives against these evils.

3. The Lentil, Kidney-Bean, and Others.

Besides the bean and the pea, there are various plants of the rich natural family to which they belong, which produce seeds applicable to the purposes of human food.

In Spain, Italy, the south of Germany, and France, a greater consumption takes place of certain leguminous plants than is common in this country. These are used for haricots, soups, and other culinary preparations.

The principal plants of this class in cultivation are—

1. Ervum Lens—Common Lentil.
2. Ervum Ervilia—Bastard Lentil.
3. Ervum monanthos—One-flowered Lentil.
4. Lathyrus sativus—Cultivated Lathyrus.
5. Cicer arietinum—Chick-pea.
6. Phaseolus vulgaris—Common Kidney-bean.
7. Lupinus albus—White Lupine.

The Common Lentil, *Ervum Lens*, is familiar to us as a plant of the garden, There are several varieties of it, distinguished by the colour of their seeds, the greater or smaller growth of their stems, and the earliness of their period of ripening. The principal distinction is founded upon the colour of their seeds, in which respect they are divided into the brown and the yellow.

The species *Ervum Ervilia* is a native of the south of Europe. It is distinguished from the last in its botanical characters, but not in its uses.

Lentils have been cultivated from the earliest times. They are greatly used over all the countries of the east, and, as has been said, in various parts of Europe. They were at one time more cultivated in Europe than now, but have generally given place to the bean and the pea, the comparatively small quantity of them which we consume being either raised in gardens, or imported from other countries.

Lentils require a somewhat light soil and warmth. They are greatly less productive of straw than the pea and the bean, and the produce of their grain is also comparatively small. Unless, then, there existed a sufficient demand and enhanced price for their seeds, there could be no benefit in introducing them into the field-culture of this country. They can always be obtained in the quantity required from countries better suited to produce them, and where the cost of labour is less.

Ervum monanthos, One-flowered Lentil, grows with more luxuriance than the last, and in its habits resembles the tare.

Lathyrus sativus, Cultivated Lathyrus, is also sometimes termed lentil. The seeds of this plant, when consumed in great quantities, possess the remarkable property of producing a paralysis or rigidity of the limbs, in the case of horses, hogs, and other animals fed largely upon them. They are, however, used extensively as food in Spain, the south of France, and other parts of Europe; and are much esteemed for fattening various animals. The plant is of easy growth, and could be readily cultivated; but it does not appear to possess properties to entitle it to supersede the common leguminous plants of our fields.

The Chick-pea, *Cicer arietinum*, grows naturally in the south of Europe. It is a beautiful plant with a very branched stem, and distinguished by its turgid legumes, and the peculiar form of its seeds. It is too delicate a plant for field culture, and degenerates when raised in the colder parts of Europe. It is one of the various leguminosæ cultivated in India under the name of *gram*.

The Kidney-bean is another plant cultivated for its seeds. Though said to be a native of India, it has been long familiar in the gardens of this country. In the southern countries of Europe, in Switzerland, Germany, and France, it is cultivated in the fields. It furnishes a nutritive and delicate food used in soups and haricots. Various species of it grow abundantly in America, and there form an article of cultivation and food.

Some species and varieties have tendrils and climb; others are without tendrils. The most commonly cultivated species in Europe is the common kidney-bean, *Phaseolus vulgaris*, of which there are several minor varieties.

It has been sometimes observed, that the legumes of this class are more used in Catholic than in Protestant countries. This doubtless, in part, results from the abstinence from animal food on certain days, when the more nourishing kinds of vegetables are resorted to. And there is no class of seeds which forms so good a substitute for animal food as the legumes. As a substitute for farinaceous food, indeed, there is the potato, which surpasses them all; but still it were to be wished that the cottagers of this country were taught to vary their repasts with those simple and delicate preparations which are familiar to the labourers of some other countries. The different species of the kidney-bean, indeed, are not with us suited to field culture. But they may be raised in the garden, or chiefly obtained from other countries, while our fields are devoted to the production of plants congenial to the climate, and fitted to the general purposes of the farm.

The Lupine is another plant whose seeds are used for food, but they are coarse and bitter. The white lupine, *Lupinus albus*, is the species most frequently cultivated for this purpose. The lupines are known to us in this country as garden-flowers. In Italy, and other parts of the south of Europe, they are cultivated in the fields; and a practice derived from the Roman husbandman is still pursued, that of ploughing them down, when in flower, for manuring the ground.

Others of the Leguminosæ might be enumerated, as forming, or calculated to form, the subjects of cultivation for their seeds; but the bean and the pea, from their productiveness, and the large growth of their stems, are calculated, beyond all the others, to retain their place in the field-culture of northern Europe.

III. BUCKWHEAT.

This plant is cultivated for the farina of its seeds. It belongs to a family, the *Polygoneæ* or Dock tribe, which is known to farmers as affording a class of common weeds.

Of the genus *Polygonum* there are two species cultivated in Europe for their seeds,—

1. Polygonum Fagopyrum—Common Buckwheat.
2. Polygonum tataricum—Tartarian Buckwheat.

The first is the species commonly cultivated. The latter is of larger growth, and is said to be more hardy, but it is less productive of seeds than the common buckwheat. A third species is cultivated in China and Chinese Tartary, Polygonum emarginatum, Notch-seeded buckwheat, which resembles the common buckwheat in its habit of growth. All these species are annual.

Common buckwheat bears white flowers tinged with red. Its stem is full of knots, and rises to the height of 2 feet or more. The plant is of rapid growth, continues to flower long, and bears at the same time flowers and ripened seeds.

Buckwheat is cultivated extensively in some countries. In China and other countries of the East it is used as bread-corn. It is produced for the same purpose in most countries of Europe, as well as for the feeding of horses, hogs, and fowls. In Germany and Poland the seeds are used for broths, gruels, and other purposes. In Russia they form a great part of the food of the inhabitants. In Spain, Italy, and the south of France, they are also an object of extensive cultivation. The Italian farmers cultivate this plant, as well as the species *tataricum*, esteeming the latter in some cases as ripening more early. Buckwheat was cultivated at a very remote period in England, but it has now gone much into disuse. The buckwheat is a plant very generally diffused, owing in part, it may be believed, to the little labour required in cultivating it; to the short period in which it completes its growth; and to the facility with which it may be produced even on the poorest soils.

The soils suited to it are the lighter kinds. It should not be sown earlier than the beginning of May, or rather the middle of May, as the young plants are apt to suffer from frost. But as it grows with great quickness, it may be sown at any time till Midsummer.

The land should be prepared for it precisely as for pease, and the seeds may be sown broadcast at the rate of from 1 to 1½ bushel to the acre. It requires no further attention after being sown than guarding it against the depredations of birds, to which it is very subject. It may be cut by the scythe; and its subsequent management is similar to that of the other grains.

Its produce may be reckoned from 25 to 30 bushels to the acre, though this varies greatly under different states of soil and culture. It is a peculiarity of the plant that it does not ripen its seeds all at the same time, so that while a part of the plant is bearing flowers another is ripening seeds. It must be reaped, therefore, before a great part of its seeds can be matured.

The seeds of the buckwheat may be given advantageously to horses, to poultry, and to hogs. The external part of them being rubbed off by a coarse grinding, they may be used for human food like rice: they may also be converted into flour: and, in short, there is no purpose for which the grain of the cereal grasses can be used, to which the farina of buckwheat may not be applied. But though the flour is white and wholesome, it is comparatively deficient in gluten, and so does not undergo the panary fermentation like wheat; for which reason it is generally made into a kind of cakes. Another of the purposes to which the seeds of the plant may be applied is distillation.

The stem of buckwheat when green seems to be nourishing, but when dried it is hard, and not readily eaten by any kind of animals. This, and the little comparative quantity of fodder produced, are the principal objections to the extension of the culture of buckwheat in England; and yet, from the facility with which the plant may be grown, and this on soils low in the scale of fertility, its cultivation might in some cases be attended with advantage. In the Netherlands it forms a regular part of the rotation, and is sown on all soils where other grains cannot be prepared in time.

One of the purposes to which it has been applied from time immemorial, and for which, from the quickness with which it grows, it seems well adapted, is the ploughing of it down green as a manure for the land. Farmers who have made trial of this practice speak favourably of its effects: and cases may doubtless be conceived where it may be beneficially adopted. But, generally, where a good system of agriculture is established, and where a proper combination of the practice of tillage and feeding live-stock exists, a green crop, when raised, will be more advantageously applied to the feeding of animals in the first place, and then the manure which the consumption of it produces applied to the ground.

II. PLANTS CULTIVATED FOR THEIR ROOTS, TUBERS, AND LEAVES.

1. The Turnip.

Of the genus *Brassica*, or Cabbage, the species chiefly interesting to the farmer, as the subjects of cultivation, are—

1. Brassica Rapa—Common Turnip.
2. Brassica campestris—Wild Navew.
3. Brassica Napus—Rape or Cole.
4. Brassica præcox—Early Cole.
5. Brassica oleracea—Cabbage.

These species may be cultivated nearly in the same manner. But they may produce small fusiform roots, when they are cultivated for their leaves,—or for their seeds, which yield oils: or they may produce large esculent roots, when they are cultivated chiefly for their roots.

The varieties producing esculent roots are the following:—

1. Brassica Rapa—Common Turnip.
2. Brassica campestris Napo-brassica—Swedish Turnip.
3. Brassica Napus esculenta—Turnip-rooted Cole.
4. Brassica oleracea caulo-rapa—Turnip-stemmed Cabbage, or Kohl-rabi.

Those which are cultivated in the fields of this country under the common term turnips, are—

1. The Common Turnip.
2. An intermediate class, which are probably hybridal varieties between Brassica Rapa and other species.
3. The Swedish Turnip.

The common turnip has numerous sorts, distinguished by their size, form, time of ripening, and other properties. This plant has, like the others of the genus, two periods in its growth. In the first, the leaves rise directly from the root, and are large, rough, and jagged. In the second period, or that of its flowering, which is generally in the second season of its growth, it sends forth a stem, 4, 5, or 6 feet in height, with smooth pointed leaves, entirely different from its first or root leaves.

The minor varieties produced by the effects of climate, soil, and cultivation, are very numerous, and have every where local terms attached to them. For the purposes of the agriculturist they may be divided into three classes, distinguished by their form:—1. the round or globular; 2. the depressed; and, 3. the fusiform. These may be considered as types, to which the different cultivated kinds more or less approach. Fig. 154

Fig. 154.

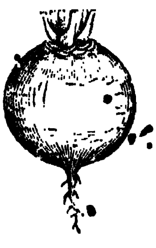


Fig. 155.

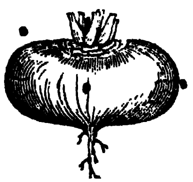
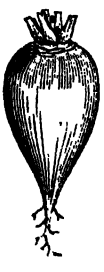


Fig. 156.



represents the round or globular kind, commonly termed the globe-turnip; Fig. 155, the depressed, frequently termed the Norfolk-turnip; and Fig. 156, the fusiform, frequently called the tankard-turnip.

They are further distinguished by the colour of the portion of the root which grows above ground. This may be white, green, or red; and the distinction is of some practical importance, because those of the white colour are regarded as the most palatable to animals, while the others are the more hardy but the less esteemed as food. These colours pass by imperceptible gradations the one into the other, but, generally, they are readily enough distinguished for the purposes of the farmer.

The turnips of the next class are distinguished from these by the root being yellow internally, and externally also under the surface of the ground. They have the leaves of the common turnip, and the habit and character of the *Brassica campestris* and *Brassica Napus*, and may be supposed to be hybridal varieties, formed between the common turnip and these species. The turnips of this class are hardy and nutritious, and resist well the winter frosts. They are distinguished from one another by the colour of the root above ground, which is sometimes dark purple, and sometimes green.

The last species is the Swedish turnip, as it is usually called. The substance of these turnips is hard and nutritious. They resist well the severities of the weather; and, retaining their juices and nutritive properties till a late period in spring, they are highly valued as a resource for livestock at that season. The leaves of the Swedish turnip are less acrid than those of the common turnip, and may be used for human food in place of cabbage.

The Swedish turnip is cultivated in the same manner as the common and yellow turnips, but it is generally sown several weeks earlier, on account of the comparative slowness of its growth. It is more difficult to be raised than the common turnip, requires a larger quantity of manure, and should be sown on a good soil. It has a property which the common turnip has not, that of bearing to be transplanted when young, so that when blanks appear in a field the spaces may be filled up by transplanting.

In the common management of the farm, the Swedish turnips are first sown, the next in order are the yellow, and then the common.

The soils suited to the turnip are those of the lighter kind. The proper place in the rotation is immediately succeeding a corn-crop, and preceding another corn-crop.

The land intended for the turnip, as for all other green or fallow crops, is to be ploughed by a deep furrow in autumn, after the preceding crop of corn has been removed. The land is to be ploughed lengthwise, in the direction of the former ridges, by being cast or cloven, with open or close furrows, as the nature of the land may require; and care must be taken that no water shall stagnate upon the surface.

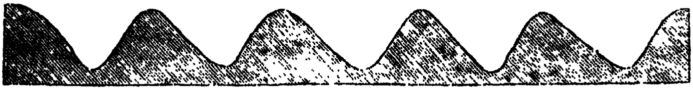
In the following spring, when the crops of corn are sown, and the potatoes planted, and when the ground is sufficiently dry, the tillage of the turnip-land is resumed. The chief period of the preparation of it is in the month of May and beginning of June.

The first ploughing is to be given across, and the ground is to be repeatedly harrowed by double turns of the harrow in various directions. This is for the purpose of pulverizing the ground, and of dragging to the surface and disengaging the roots of weeds below the ground. To assist in this operation, the roller is also to be employed when necessary; and the grubber is a useful subsidiary to the harrow and the plough. The roots of the plants disengaged are then to be gathered with care, and carried to a heap, to be mixed with quicklime and other substances, to form a compost. At the same time, loose stones and other obstacles to tillage may be removed.

The land is immediately afterwards to be ploughed in a direction traversing the last ploughing; and the same process of harrowing, rolling, and collecting the disengaged weeds, is to be repeated. The land is once more ploughed, and again the same operations are resorted to; after which the land is generally in a fit condition to be formed into drills. Should this not be so, the operation of ploughing, harrowing, and gathering of weeds, is to be repeated, and this until the ground is cleared of injurious roots, and reduced to a friable state.

After this preparation, the land is to be formed into drills. This is to be done by single-bout ridgelets, precisely in the manner described for the bean. The width of these drills, and consequently the distance from centre to centre, may be from 27 to 30 inches, which is necessary to allow the intervals to be tilled by the horse-hoe, and to admit of a sufficient circulation of air between the rows. A transverse section of the drills will appear thus—

Fig. 157.



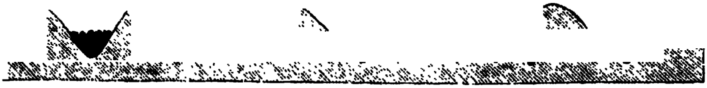
The manure chiefly applied to this crop, in the ordinary course of management, is farm-yard dung. This requires to be well prepared. It is conveniently carried out, as was formerly explained, to the field, and laid in one or more large heaps. It is necessary to turn it over once, or oftener, in order that it may undergo the necessary degree of fermentation.

When the drills are thus formed, the dung is to be carried forward to them in single horse-carts. The driver directs the horse along the interval of a drill, consequently each wheel of the cart will be in the interval adjoining. As the cart moves along, the workman pulls out the dung into little heaps, by means of the dung-drag (Fig. 82), and thus the dung is laid in heaps in the hollow of each third drill, at the distance from one another of 8 or 10 feet. For the economy of labour in this process, one or more persons are at the dung-heaps to fill, one person drives the loaded carts to the drills and brings back the empty ones, and one person at the drill drags out the dung in the manner described.

Following the carts are persons, generally females or young lads, with light three-pronged forks (Fig. 73), to spread out the dung from the little heaps regularly along the hollow of each drill. Four persons should be employed for every three drills, the duty of one of them being to go before and distribute the dung lying in the centre drill between it and each o the adjoining ones; while the three others, taking each a drill, spread the dung regularly along the hollows.

A cross section of the drills with the dung deposited in the intervals will appear thus—

Fig. 158.



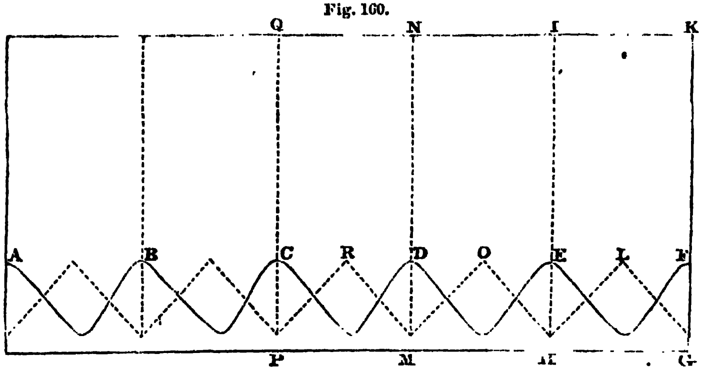
The dung being spread in this manner is immediately covered by the common plough, which, passing down the middle of each drill, splits it into two, so that a new drill is formed, whose top is immediately above the former hollow of the old drill. thus—

Fig. 15

The operation of splitting the drills is performed by the common plough as follows:—

A double mould-board plough, by passing along the centre of each drill, would simply perform this operation. It is, however, more frequently done by means of the common plough in the following manner. In Fig. 160. let ABCDEF represent the apices of the old drills; let the plough be supposed driven in the direction from H to I, that is just along the centre of the drill, until it arrives at the headland at I; let it then turn to the right, and entering at K, the centre of the next drill, pass along the centre of the drill in the direction KG. This will form the first drill, of which the apex is L. Let the plough then turn to the right, and proceed by the centre of the next drill MN. Let it then turn to the right, and proceed from I to H. In this manner the drill of which the apex is O, will have been formed, and this, it will be observed, by two

Fig. 160.



bouts of the plough, first from M to N, and then from I to H. It is thus a double-bout drill. Let the plough, in like manner, turn from H to P, and proceed along the centre of the next drill in the direction PQ. Let it then return by MN, and so form the drill of which the apex is R. By proceeding in this manner throughout the field, each of the new drills covering the dung will be formed, appearing in transverse section as before represented.

The dung is now completely covered, and a new drill for the reception of the seeds at once formed. The double mould-board plough would perform this operation by one turn, but the common plough does it more completely by two turns.

Instead of depositing the dung in the manner described, it is sometimes laid upon the stubble after harvest, and is then covered by the first ploughing given. This, however, infers that a supply of manure remains upon the farm from the previous winter, or that it has been obtained elsewhere. The most economical employment, however, of manure made upon the farm, is in the spring immediately succeeding the winter in which it has been produced.

As liberal an expenditure of manure as can be afforded is always to be made in the case of the turnip-crop, the goodness of which will much depend upon the fertility which is communicated to the soil. But, in the common management of farms remote from the means of procuring external supplies, and where turnips are cultivated on the great scale, it is necessary to economise this valuable substance ; and 10 or 12 tons per acre are considered to be the ordinary manuring on a regular turnip-farm.

Sometimes lime is applied to the turnip-crop together with dung. This may be done by laying the lime upon the stubble after harvest, or by spreading it upon the ground and harrowing it well previously to the forming of the drills.

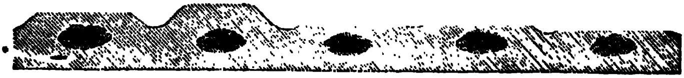
Street-dung is a good manure for turnips. Sea-weed, too, is used ; and ashes generally produce a good effect, by causing the seeds to vegetate quickly ; though their fertilizing effects are not usually of a permanent nature, and they are not so much esteemed as farm-yard dung.

Bruised bones have been employed with the best effects for the manuring of turnips, and are regarded as an important subsidiary to the other manures upon a turnip-farm. They may be applied in two ways, either by being spread in the hollow of the drills, and covered in the same manner as dung, or by being sown at the same time with the seeds, by means of an apparatus attached to the sowing-machine. Rape-dust may also be applied to the turnip-crop. It is usually deposited in the ground at the same time as the seeds, and by means of an apparatus similar to that employed in sowing bruised bones. When the manures are sown, the drills are not reversed as in the case of the application of dung, but made at once in their most perfect form by a double bout of the plough.

The apparatus employed for depositing the manure is variously constructed. It may consist of a large box placed upon the frame-work of the sowing-machine. Moving in the lower part of this box is a spindle, with teeth or pinions upon it. These teeth, working amongst the bruised manure, cause it to fall through apertures at the bottom of the box, as in the case of the broadcast sowing-machine. The bruised manure falling into funnels, is conveyed to the ground just before the tubes which convey the seeds of the turnips to the ground, and in this manner both are sown at the same time.

But reverting to the case of manuring with dung, which is the most frequent in practice: the dung, it has been said, having been spread, is covered, and new drills are formed, which are now ready for the reception of the seeds.

The seeds are sown by the turnip-drill (Fig 35), which is drawn by one horse, the horse walking in the hollow of the drills, and the workman who guides it holding the handles of the machine. By this operation, the drills are compressed by the roller in front of the coulters formerly represented. A transverse section of the drills will now appear thus:



The several operations of forming the drills, of spreading the dung, of covering it by the plough, and of sowing the seeds, are to be carried on in close succession. The dung is to be immediately covered, so that none of it may be lost by evaporation; and to promote the early vegetation of the seeds, they are to be sown while the earth is newly turned up and moist.

The seeds of turnips may be sown upon a flat surface in rows, as well as upon the raised drills here described. But in the parts of this country where the turnip culture is the most extensively and perfectly executed, the system of drills is preferred for the following reasons:—

1*st*, The manure can be more readily covered, and by being applied close to the roots of the plants, a smaller quantity will suffice to produce a given effect.

2*d*, The land can be kept more dry, and crops accordingly raised upon land so wet as otherwise to be incapable of yielding returns of any value.

But whether the method of sowing in rows upon a flat or drilled surface be adopted, either is far superior to the practice of sowing broadcast.

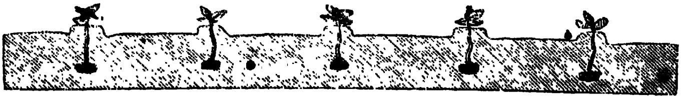
By sowing in rows, the plants can be more cheaply and quickly hand-hoed, the process being so simple as to be taught to young persons in a few hours; whereas, when the plants are not regularly disposed in rows, considerable experience and time are required; and what is of greater importance still, the land under the one system can be more thoroughly hoed and cleaned during the growth of the plants than under the other.

The quantity of seeds sown may be 2 lb. to the acre. It is not proper to make the quantity excessive, but a sufficient number of seeds must be sown to provide against the loss of plants from the attacks of insects, and from other contingencies.

In the climate of the north of England and Scotland, the period of sowing is generally from the first to the end of June, though it is sometimes continued till the middle of July. The turnips sown after the latter of these periods seldom attain to a proper size, and when sown earlier than the first of June they are apt to shoot forth their flowering stem before winter, by which the nutritive juices of the root are exhausted. The best period of sowing, under the condition of climate supposed, is from the beginning to the middle of June: but in different countries the period of sowing must be suited to the warmth of the climate and quickness of vegetation.

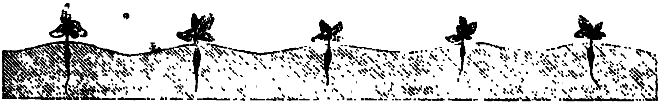
When the plants have assumed what is termed the rough leaf, and are about two inches in height, the process of hoeing is to commence. This first hoeing may be performed by the small plough (Fig. 36) drawn by one horse, going and returning along the interval of each drill, and cutting off a shallow slice of earth as near to the turnips as possible. Or the same operation may be more conveniently performed by the hoes with coulters (Fig. 37, 39, or 40), passing along each interval once. A section of the ground appears thus:

Fig. 102.



After this operation the plants are hoed to the proper distance from one another by the hand-hoers, with the hoe (Fig. 79). Each takes a drill, and, standing facing the rows, by an alternate pushing and drawing of the hoe from and towards him, thins the turnips, leaving them standing singly at the distance from one another of from 9 to 10 inches. By this operation the rows of the turnips are cleaned of all weeds, the superfluous plants of turnips cut up and pushed into the intervals where they die, and the plants to be preserved left standing at the distance required from one another. A transverse section of the drills will then appear thus:

Fig. 163.

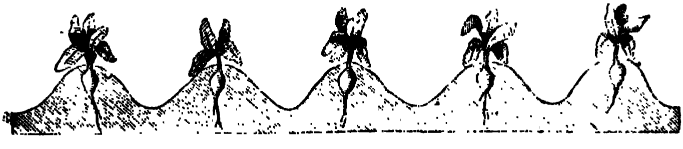


Soon after the operation in question, weeds will again spring up in the intervals of the rows and amongst the plants. In the course, therefore, of 12 days or more, the horse-hoe again passes along the intervals of the drills, cutting up all the weeds that may have sprung up; and afterwards the hand-hoers, with the same instrument as before, hoe round the plants, and carefully single any that may have been passed over in the first hoeing.

Sometimes the horse-hoe passes again along the intervals, but more frequently the hand-hoeing concludes the process, the weeds being now kept down by the rapid growth of the plants, and the overshadowing of the intervals by the leaves.

Very frequently, however, after an interval of 8 or 10 days from the last hand or horse-hoeing, the earth is laid up to the stems of the plants by the double mould-board plough passing along the intervals of the rows, and ridging up the earth thus:

Fig 164.



The design in this operation is, that any weeds remaining in the intervals after the former hoeings, may be destroyed, and that the turnips may be kept more dry during wet weather in the months of winter.

This concludes the culture of the turnip, which now grows rapidly without further care; and by the beginning of September, the leaves of a good crop will have covered the entire surface of the field.

Towards the end of October or beginning of November, when the pastures have decayed, the turnips are to be used for food.

The manner of consuming them is various, and dependent upon the kind of stock to be fed:—

1. They may be pulled up and carried to a separate field, and spread upon the ground, to be consumed by the feeding animals.

2. Where sheep are to be fed, the animals may be penned upon the ground, and thus allowed to consume the turnips where they have grown.

3. The turnips may be pulled up and carried to the oxen or other animals in their feeding stalls or yards, in the manner to be afterwards explained.

4. The turnips may be taken up and stored in a convenient place for use. In this case they are to be pulled from the ground about the beginning of November, or previous to the frosts of winter. In the act of pulling, a slight twisting motion is given to disengage the earth, and then the tap-root, and the tops or leaves, are cut off, each by stroke of a hook or knife, care being taken not to wound or injure the root. The roots thus divested of their leaves and tap-roots, are to be carried to some convenient situation, placed on a dry base of 6 feet or more in breadth, and piled up as high as they will conveniently stand. The heap is then to be thatched with straw, and secured with straw-ropes, thus forming an oblong heap of the size required.

Turnips may be preserved by storing for some months, but they lose a portion of their nutritive juices, and become less palatable to cattle. They are, therefore, best consumed soon after they are taken from the ground. The reasons that may exist for storing are: 1*st*, The necessity in countries where the winters are long and severe, and the snows deep, of having a surplus store in readiness; 2*d*, The expediency of clearing land for the purpose of sowing any particular crop, previous to the time at which it may be convenient to consume the turnips; and, 3*d*, The advantage of removing them from certain wet and clayey lands, before the season arrives when they could not be removed without injury to the surface.

Turnips suffer greatly from sudden alternations of frost and thaw, in spring, particularly, when the heat is considerable, and when they have no covering of snow to defend them. There is no remedy for this evil but to consume the turnips if possible before putrefaction has begun. The storing process is a considerable preventive of the decay of turnips in spring. A practice, too, is sometimes resorted to, of covering the turnips in the rows where they grow before winter. This is done by the plough passing along the intervals, and raising the earth over the turnips, which is found to be a tolerably good defence against the effects of extreme frosts.

In frosts, the turnips are often so hard and frozen to the ground as not to be raised without great labour. In this case they must be taken up by hoes, it being impracticable to pull them by the hand. Often the turnips are cut into pieces before being given to the larger cattle and sheep. This is effected by the machine (Fig. 47) formerly described. But these and other details with respect to the consumption of the turnip, will be explained when treating of the rearing and feeding of live-stock.

Sometimes the turnip is cultivated for its seeds for sowing; and by careful selection, varieties of the plant may be multiplied and improved. A manner of procuring a good variety of turnip, is to pick out from the field in autumn or the following spring the largest and best formed turnips, with the smallest tops and tap-roots, and to plant them in some separate place in rows. The plants will flower in spring, and when their pods are formed, they are to be guarded from the depredations of birds, and the stems are to be cut down and well dried, and then either stored in stacks, to be thrashed out when wanted, or thrashed at once, and the seeds preserved in the granary.

The diseases and accidents to which this valuable plant is subject are considerable.

The chief danger to it is in the early stage of its growth, when either the seed may not vegetate from a deficiency of moisture, or when the plant may be destroyed by the attacks of animals. Should the turnips fail from either of these causes, the sowing is to be repeated by simply driving the sowing-machine along the drills, or by again ridging up the compressed drills, and then sowing them.

The insect the most destructive to the turnip during the first stage of its growth, is familiarly known to farmers by the name of the turnip-fly. It is a species of beetle, the *Haltica nemorum* of entomologists. This creature attacks the plant as soon as the cotyledon leaves are upon it; when the plants have put on the second or rough leaves, they are regarded as safe from injury from the beetle, and hence a security against its ravages is a rapid and vigorous vegetation of the plant.

There are other creatures that attack the plant at this stage, and when it has escaped these early enemies, it is sometimes attacked by the larvæ of a species of saw-fly. These, however, are more partial enemies to the turnip plant than the beetle, though occasionally they are very destructive.

The turnip is liable to a kind of blight. Another of the diseases to which it is subject is a species of canker. The disease attacks the root, but its presence is first discovered by the leaves becoming flaccid and drooping. The roots, in place of enlarging into their usual form, shoot away into excrescences. They become acrid, and even at an early stage of the disease animals reject them. Towards autumn they become ulcerated, and at length decay. A species of maggot is found in them, but whether this be a consequence of the disease or a cause of it, has not been satisfactorily determined. This destructive disease has been long known in England, and frequently receives the name of "fingers and toes." It sometimes affects particular districts, and generally continues its ravages for many years in succession. The only sure remedy for the disease is to cease cultivating the turnip when it appears, and substituting for a time some other species of crop. When turnips follow in a regular rotation, as at intervals of four or five years, by omitting them once and substituting a crop of potatoes, the disease will afterwards be greatly mitigated, and sometimes removed.

The extended culture of the turnip has enabled us to carry the practice of breeding and feeding our domestic animals to a state of perfection, in which no other country has yet been able to rival Great Britain. The cultivation of the plant in rows, instead of the former method of broadcast, may well be regarded as an improvement of the highest importance. It has enabled the farmer to secure abundant returns, which the former methods of cultivation did not admit of, and so to increase the number of useful animals that may be maintained upon the farm, and to subject the lighter soils to a species of culture more beneficial than any other that had been before devised for them.

2. RAPE.

The plants usually cultivated under the name of Rape, are the fusiform varieties of the following species of Brassica:—

1. Brassica Napus—Cole or Rape.
2. Brassica campestris—Colza.
3. Brassica Rapa—Fusiform Common Turnip.
4. Brassica præcox—Early Cole.

Brassica Napus, Cole or Rape, is a native plant. All its leaves are smooth. When cultivated, it produces abundance of leaves and seeds. The leaves are used for food, and from the seeds oil is expressed.

Brassica campestris differs from the last in having its lower leaves slightly rough. It has been thought to yield a larger quantity of oil than the last.

The other kinds of rape, namely, the fusiform varieties of *Brassica Rapa*, and *Brassica præcox*, are of more partial cultivation, and are not reckoned so productive of leaves and seeds as the other species.

The rape is a hardy plant, and has a wider range of soils than the turnip. It grows, like the turnip, on the lighter soils, but may be raised also on the stiffer, and even somewhat humid clays. It requires less of culture and manure than the turnip, and consequently can be produced under circumstances in which the turnip cannot be profitably cultivated.

The manner of cultivating the rape for its leaves is very similar to the manner of cultivating the turnip; but it admits of variations suited to the soil, the period of sowing, and other circumstances.

The land intended for rape should, as in the case of the turnip, be ploughed before winter. In the following season it should be cross-ploughed, harrowed, rolled, and cleaned of the roots of weeds. It then should be ploughed a second time, harrowed, rolled, and cleaned; and a third ploughing and series of harrowings being given, it will be fit for being sown.

The land may be formed into drills, manured and sown precisely as in the case of turnips, but with narrower intervals between the rows. A distance of 24 inches will suffice to admit of the operation of the horse-hoe.

The rape-seeds may also and conveniently be sown in rows upon a flat surface, and in like manner at intervals of 24 inches. Under this method, when the ground has been ploughed and harrowed, and the root-weeds have been removed, the dung may be spread upon the surface, as in the case of summer-fallow, and covered by the plough. After this the rape-seeds are to be sown in rows, and the land being rolled, the seeds will be covered.

Instead of dung, bruised bones may be employed. These should be well ground, and sown by a machine. Rape-dust may be also used, and this forms a good manure to the plant.

Whether the method of sowing on raised drills, or in rows on a flat surface, be adopted, the land is to be hoed after the plants have come above ground and fully assumed their second leaves. This may be done by the hoeing-plough, with coulters; immediately following which go the hoers, who, with hoes 6 inches broad, single out the plants to the distance from one another of about 8 inches. Another horse and hand hoeing are given; and these complete the culture of the rape.

Very often, however, the rape-seeds are sown broadcast; and if the land is well prepared, good crops can be raised in this manner.

The rape admits of being sown later than the turnip, and therefore, when the land cannot be prepared in sufficient time for the turnip, it is yet ready for a crop of rape.

The great advantage which the culture of the rape presents, is the facility with which the plant may be produced, and on inferior soils, where the turnip could not be beneficially cultivated. The rape may often obviate the necessity of an entire summer-fallow upon such soils; for it may be eaten upon the ground with sheep in the month of September, and thus a crop of wheat be sown in the same year. Under this system, very inferior clays have been made to produce excellent crops of wheat.

The rape is frequently sown as a kind of intermediate crop. Thus, after a crop of corn has been reaped, rape may be sown upon the ploughed stubble, and will in the following spring yield a tolerable supply of green food.

After land has been prepared for summer-fallow, but when it is not intended to sow wheat in that season, but to take oats or barley in the following spring, then rape may be sown with advantage. In this case, the land being already well prepared, the rape will grow with vigour, and be ready in spring to be consumed before the spring crop is sown.

Rape, too, may be frequently sown after early pease and potatoes, and produce an exceedingly good crop.

It is for this kind of intermediate cropping that the rape is in a peculiar degree adapted. It may be sown, it has been said, much later than the turnip, and in cases where the turnip could not be produced.

Rape may be mown for forage, and will spring again. It is best, however, consumed on the ground by sheep penned upon it.

Rape bears well to be transplanted. It may thus be sown in seed-beds, and then transplanted to the place where it is to grow. By being prepared in a seed-bed, it can be got ready to be planted on stubble-land in autumn, as soon as the crop is removed. This practice, however, is chiefly applicable when the rape is cultivated for its seeds, and will be adverted to when considering the rape as a plant producing oil.

3. The Cabbage.

The Cabbage, commonly so called, is *Brassica oleracea.* This species assumes a vast variety of form and character. The wild cabbage, from which the greater number of the cultivated kinds are derived, is a little plant growing upon our sea-coasts. Yet to this plant we certainly owe the greater part of the numerous varieties cultivated in our gardens and fields. We cannot, indeed, be assured of the origin of all the cultivated kinds, for, besides the variations produced by climate and art, all the species of Brassica form hybrids with one another.

The different kinds in cultivation may be arranged in different classes, according to their general aspect and more popular characters :—

1. Those which bear their leaves on stalks without their being formed into a head. Some of those have crisped leaves, and are a class of hardy pot-herbs every where familiar in the culture of the garden. Others have smoothish leaves with long branched stems. These comprehend the largest and most productive of all the cabbages,—the Jersey cole, the thousand-headed cabbage, and others.

2. Those whose leaves are formed into a large head. These comprehend the larger cabbages cultivated in the fields. The savoys of our gardens are allied to this class.

3. Those whose roots become napiform, as the Kohl-rabi.

4. Those in which the stem divides and forms a corymbose head, as in the cauliflower and broccoli.

The cabbages of the first class, with crisped leaves, frequently termed Greens, are very hardy. They are cultivated pretty extensively in some parts of the North of Europe; but in others they are chiefly regarded as pot-herbs, and confined to the garden.

The branched kinds with smoothish leaves are the most productive, but at the same time they require a good soil and favourable climate. Their leaves are stript off as they are required for use; and as these are constantly supplied by fresh leaves, the plants yield a succession of forage throughout a great part of the season, and they remain growing for several years.

There are different varieties of these larger cabbages, which are more or less valued in the places where they are cultivated. The thousand-headed cabbage, *Chou à mille têtes*, is remarked as possessing a greater number of shoots, the cow-cabbage, as growing more to one stem, and producing cream-coloured flowers; the Jersey cole, as being similar in its growth, and producing yellow flowers.

In Jersey and Guernsey, where the cultivation of these plants is well understood, they are sown in beds in autumn, and planted out in succession from November till February. About the month of April, the farmers begin with the first sown to strip off their under leaves for use. They give them to their cows, hogs, and other stock. They cut them in small pieces, and mix them with bran and other farinaceous substances. During the summer they continue this process of stripping off the leaves, the plant in the mean time rising to the height of several feet.

This plant requires a good soil and plentiful manure, and is regarded as a great exhauster of the soil. It perhaps yields a larger proportion of nutriment within the same period than any other forage-plant. It may be presumed that it is not well fitted for general cultivation, and in this country will only succeed in favourable situations, as the south of England and Ireland, and the beautiful little islands where it is now cultivated.

The kinds of the cabbage which are best suited to general cultivation in the fields are the large-headed field cabbages, as the Large Scottish or Yorkshire, the Drumhead, and the American. These and other names, however, are frequently applied where there is no real distinction. They are all known by their large leaves, which, as the plant advances, collapse and form a dense head.

The next class consists of those in which the root becomes napiform. There are varieties, the principal of which is the Kohl-rabi. This plant is cultivated in Germany and the north of Europe. It is valued as a resource for cattle in winter. While it produces a root like a turnip, it at the same time sends forth stems bearing leaves like a cabbage. It is not only hardy, but keeps better in store than any plant of the cabbage kind. It may be cultivated in the same manner as the Swedish and yellow turnips ; but the experiments that have been made with it in this country lead to the inference, that it is not equal to those turnips for the purposes of feeding.

The cabbages of the last-mentioned class, as the cauliflower and the broccoli, are entirely limited to the garden.

Of the different kinds, therefore, it appears that the large field-cabbage, whatever name it may receive, is that which is best suited for common field-culture.

The cabbage may be cultivated like the turnip, being sown in drills, and tilled and hoed in the same manner. The proper method, however, of cultivating the cabbage is to sow the seeds of it in the first place in beds, and then to plant it by the dibble or spade in the situations which it is to occupy.

The land is to be ploughed with a deep furrow in autumn, precisely as for the turnip : it is to be cross-ploughed in spring, harrowed and rolled if necessary, cleaned of root-weeds, and again ploughed ; and the same operation of harrowing and collecting weeds is to be repeated. If the land is now in a fit state to be formed into drills, this is to be done ; if not, it is to be again ploughed, harrowed and cleaned, and finally formed into drills 30 inches from centre to centre, the dung being spread as in the case of the turnip culture, at the rate of not less than 20 tons to the acre.

In the mean time the young plants are being prepared. For this purpose, the seeds must have been sown as early in spring as the weather allowed, on some land in good heart, well sheltered, and carefully digged. This should have been done in the month of March; and about the middle of May, or as soon afterwards as possible, the plants are to be set along the tops of the drills by the dibble, at the distance between each plant of 2½ feet. The land should be moist when this operation is performed.

The cabbage is usually intended for spring food. If designed in any case for early feeding, the seeds should be sown in the previous autumn, and well protected from the frost. They will be ready to be planted out on the drills early in May, and they will be fit for use in October.

The intervals of the cabbage are tilled by the horse and hand hoe, as in the case of the turnip; and the distance of the plants affords the opportunity of doing this with effect. The last tillage should be that of earthing up the soil thoroughly to the stems of the plants.

Cabbages do not endure storing like turnips, and therefore, they should be consumed nearly in proportion as they are pulled from the ground.

They should be carried to the yards and sheds, and given to the cattle in troughs or mangers, the stem being cut off by a hook or knife. When they are to be given to sheep, they should be carried to a dry field, and laid upon the ground. They may be boiled or steamed, but they are usually given in a raw state. They are relished by all feeding animals, and furnish a wholesome nutritive food. They are chiefly valued, however, for the feeding of milch cows, to which purpose they are largely applied in some of the dairy-districts in England.

The cabbage is a more nutritive plant than the turnip, and will feed a greater quantity of animals from the same extent of ground. It is suited to a different class of soils from those to which the turnip is suited, the soils best adapted to the cabbage being the clayey.

The cabbage is generally regarded as an exhausting crop.

In this respect it probably follows the law of all plants that yield a greater degree of nourishment, abstracting a corresponding quantity of nutritive substances from the soil. But then if it returns back a corresponding quantity of manure by its consumption, it cannot be said to be an exhauster of the farm. On the Continent, and in the districts of England, where it is cultivated, it is known to be a plant that requires a good supply of manure. But then it is known to be a rich forage-plant, and calculated to replace that manure by its consumption on the farm.

The expediency, however, of extending the culture of the cabbage in any part of this country, depends mainly upon the nature of the soil and climate.

The turnip and the potato are substitutes for the feeding of live-stock, which are more readily and safely raised over a great part of the soils of this country; and hence the culture of the cabbage is more confined to particular situations, and these where the climate and other circumstances are favourable. Thus, north of the Tweed, the cabbage, though often tried, has never been greatly cultivated, and it is not until we reach the more southern parts of the kingdom, that the culture of the cabbage can be said to be fairly established as an object of field-culture. There the crops of it are heavy in proportion to the crops of turnips: while in the more northern parts of the country, the crops of turnips are heavy in proportion to the crops of cabbage.

Nevertheless, even in the parts of this country less favourably situated, there are many cases in clay-land districts, in which the cabbage may be substituted for the bean in the rotation. But whether or not it be expedient to introduce the culture of the cabbage as a regular part of the rotation, it can always be cultivated successfully on the small scale. It is on the smaller possessions accordingly that we see the most frequent patches of the cabbage, and this is as it should be, because the state of possession admits of more attention being paid to the tillage and manuring of the plant, than might be consistent with the regular labours of a more extended farm.

4. The Potato.

This plant, of the genus *Solanum*, is of the natural order *Solaneæ*, or the Night-shade tribe. The juices of the plants of this family possess certain narcotic and stimulating properties, which in excess are poisonous. But these properties exist in different species in different degrees; so that, while some of them, as the deadly night-shade, are highly poisonous, others are merely narcotic, and others yield common articles of food. Even the tubers of the common potato, which are regarded as so nutritive, possess certain poisonous properties, which are expelled by heat in the process of preparing them for human food. Of the species of Solanum, several are cultivated in different countries for their uses in domestic economy and the arts; but of all the species, the most important to the human race i—

Solanum tuberosum—the Tuberous-rooted Night-shade, or Potato.

This species is a native of America, and it has been observed, that it is the most precious gift of the New World to the Old. It appears to have reached Europe from the Spanish settlements: but it came to England from Virginia, being brought to it, as is supposed, by the brave and unfortunate Sir Walter Raleigh. The history of its introduction into the various countries of Europe and Asia is remarkable. It was for the most part received with tardiness, distrust, or contempt; while another plant of the same natural family, the Tobacco, possessing merely the properties of a narcotic, was no sooner made known than it was received with eagerness in every part of the habitable world.

The use, however, of the potato has constantly extended: it forms now a great part of the food of the inhabitants of Europe, and its more general consumption has, beyond all question, lessened the hazards of famine, and added greatly to the comforts of the labouring people. It grows exempt from the hazards to which almost all other crops are subject. Its tubers ripen under the earth, and so are defended from the effects of winds and storms. It yields a large quantity of fecula, which can be obtained separately from the tuber. It may be used in its natural state, either directly as the food of man, or for the feeding of domestic animals. It has a wider range of soils and temperature than most other cultivated plants, grows on soils the lowest in the scale of fertility, and is capable of supporting a greater number of human beings upon the same extent of ground than any other plant cultivated in the temperate regions. Under every system of agriculture it is a beneficial object of culture; and to the settlers of new countries, it is, of all the cultivated plants, the securest, the most easily produced, and the least liable to the contingencies of the seasons.

The potato rises with a branched and succulent stem bearing white or purplish flowers. The fruit is a round berry, of the size of a little plum, green at the first, but growing black when ripe, and containing numerous small seeds. The root has many tubers attached to it of a round or oblong form.

The potato may be propagated from its seeds, and it is in this way that new sorts are obtained; or it may be propagated by planting the tubers, in which case plants similar to the old are produced.

When the plants are propagated from the seeds, they require to be planted for several successive years before the tubers attain their full size. When they are raised at once from the tubers, they yield their full produce in one season; hence, when the purpose is to obtain tubers for food, they are always produced by planting the tubers.

But one tuber generally contains many buds or germens, from each of which a stem will arise: hence it is not necessary to plant the whole tuber, but only such part of it as may contain one of these buds or germens.

The tuber, therefore, though it may be planted entire, is for the most part cut into several pieces, care being taken that each piece shall contain at least one bud, or eye as it is termed. These buds are sufficiently visible on the surface of the tuber, and hence the operator has no difficulty, by cutting the tuber through longitudinally or transversely, as may be required, in preserving one bud at least upon each piece. Small tubers are generally cut into two, the larger into three, four, or sometimes five, if the potato be very large. When they are cut a considerable time before being planted, they should be spread thinly on the ground, and turned from time to time, that they may not ferment. When proper care is bestowed, large and well-shaped tubers are selected for planting.

Many approve of planting the entire tuber, a practice to which no objection exists, further than that experience shows, that nearly an equal effect may in most cases be produced by dividing the tuber, while there is a certain economy in the practice. Nevertheless it is certainly better to plant the whole tuber. Others have recommended the merely scooping out of a small part of the tuber containing the bud, and planting the pieces, and doubtless good crops have been raised in this way. The approved practice, however, and beyond a doubt the proper one, is either to plant the tuber entire, or to cut it into pieces, so that one eye shall be upon each.

It has been observed that eyes taken from tubers that have not been fully ripened, are more vigorous than those that have been taken from such as have been very fully ripened. This leads to a rule in practice, that the tubers to be planted shall be those which were taken up before the stems had begun to decay in autumn.

It has been observed, too, that eyes taken from the upper part of the tuber, which is always less matured than the lower part,—and which hence is called the watery end, in contradistinction to the other, which is called the mealy end,—ripen earlier than those taken from the lower or mealy end. This has given rise to a practice adopted in some places, where very minute care is bestowed on the culture of the potato, of dividing the tuber transversely into three parts, and planting the sets separately: those taken from the upper or watery end for the early crop, the centre ones for the intermediate crop, and the lower ones for the later crop. But such niceties, it is to be observed, are in no way essential in the common practice of the farm.

The varieties of the potato, as produced first from seeds and afterwards continued by sets, are exceedingly numerous, and constantly varying as the old ones degenerate, or as better ones are brought into notice.

The most obvious distinction of the varieties of the potato is into the early and the late. The power of early ripening exists in a greater degree in certain individuals than in others: the early ripening kinds are thus obtained in part by selection and the property becomes permanent in the progeny. The early potatoes are more raised in the garden, the late ones in the fields. But very often the early potatoes are also raised in the fields, and where a demand exists for their produce, as near large towns, they can be cultivated in the field as well as in the garden. Potatoes, with relation to their periods of ripening may be classed as follows:—

1. The earliest kind used by gardeners, which are generally termed forcing potatoes. These are not at all intended for field-culture.

2. Early kinds, which may be subdivided according to their order of ripening: First, the earliest sorts in common cultivation, as the Early-shaw, the American-Early, the Early-champion, and others: the next an intermediate class, which would be considered as late in the gardens but early in the fields; such are those termed the Early-red, the Cape of Good Hope kidney, and the Bread-fruit.

3. The later kinds, forming the common subjects of cultivation in the fields, which may, in like manner, be subdivided according to their order in ripening; such are those termed the Red-apple, the Bedfordshire kidney, the Lancashire pink, and numerous others.

4. Those of a large kind, but of so coarse a nature as to be cultivated only for feeding domestic animals; the best known of which are the Late champion, the Ox-noble, and the Surinam potato.

New varieties of the potato are obtained, it has been said, by cultivating from the seed. Many of the early potatoes, however, do not blossom at all. To obviate the effects of this, Mr Knight adopted an expedient which deserves to be noticed, both as being calculated to effect the purpose intended, and as illustrating the habits of the plant. He removed the tubers as they were being formed, by which means he directed the vegetable juices to the stem and parts of fructification, and so was enabled to produce blossoms and seeds.

The mode of procuring new varieties from seeds is simple, but tedious. Some of the largest and best-formed berries, when fully ripe, which is denoted by the change of their colour, and by the stalk having become withered, are plucked, and the pulp separated from the seeds, which are then dried in the sun. These seeds are to be sown in the following spring, and the produce to be taken up early in October. They will then have nearly attained the size of small plums. The best of these are to be selected and carefully preserved. In the month of April following they are to be planted at a distance from one another of from 15 to 18 inches; and when they rise about 2 inches above ground, they are to be covered with earth by the hoe, which operation may be repeated during the season, and they are to be kept free from weeds. When they have arrived at maturity, which will be denoted by the decay of the several stems, they are to be taken up in succession as they ripen, keeping the early separate from the late: and the produce of each stalk is again to be planted in the following spring. A judgment of the properties of the potatoes will then have been formed, and those are to be reserved for cultivation which are approved of. It will be found that, whatever had been the parent stock, the seeds will produce numerous varieties, some white, some dark in the colour, with tubers of different forms, round, oblong, and kidney-shaped. This is a tedious process, but necessary when it is desired to cultivate new varieties from seeds.

The soils best adapted to the potato are of the drier and lighter class. In wet clays the return is inferior in quality and productiveness. Deep dark peat often produces large crops; and it is one source of great value in this plant, that it can be cultivated successfully on the soils termed peaty.

Although the lighter soils are, generally speaking, best suited to the potato, there is one variety, the Surinam potato, or as it is sometimes called the yam potato, which grows best on stiff soils.

Potatoes, in the common course of farm culture, are cultivated by the plough; but they are frequently also, and this in many cases with great convenience, cultivated by the spade; thus in woods in new countries, in plantations and steep banks inaccessible to the plough, or in certain cases in peat too soft to bear the treading of cattle, the spade may be beneficially substituted for the plough.

An example of this method of culture is what is termed the lazy-bed system. This consists simply in forming beds of a few feet in width, with intervening spaces or trenches; these beds being digged, the dung is spread upon them, and the potatoes planted in rows upon the manure at distances from one another of ten inches or more. They are then covered with earth thrown upon them from the trenches, and generally after they have appeared above ground they receive a second covering of earth, so as to be covered in all to the depth of from 4 to 5 inches.

Inartificial and rude as this method may seem, there are cases in which it can be practised with advantage; such are in deep bogs where the plough cannot act, and peaty soils which are brought under culture for the first time. And it is surprising how large the crops are which are sometimes raised in this manner, and in how good a state the land is left from the deep tillage which it has received.

The cultivation of the potato, however, upon the larger scale of farm-culture, must necessarily be performed by the plough and the working cattle upon the farm.

The potato forms a good preparative crop for any of the cereal grasses; and it may follow any crop of corn. Sometimes potatoes are planted upon land newly broken up from grass. In this way they may be cultivated beneficially in regard to produce: but this is a deviation from the general rule, that the potato shall follow a crop of corn and be succeeded by one.

As in the case of preparing land for the summer-fallow, the land intended for potatoes is to be ploughed before winter, receiving a furrow of 8 or 9 inches in depth. The ploughing should be lengthwise, so as to keep the ridges dry, and prepare the ground for early tillage in the following spring.

In spring, as soon as the other labours of the farm allow, and the land is sufficiently dry, it is to be cross-ploughed, and harrowed by repeated double turns of the harrow in every direction. The roller also, if necessary, is to be employed to reduce the soil, and all the root-weeds are to be carefully collected by the hand, and carried away to be formed into a compost, as was described in the case of the management of summer-fallow.

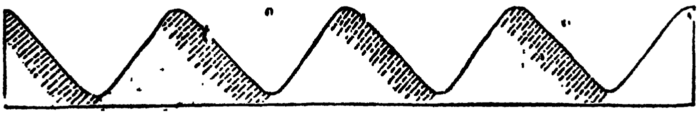
The land is next to be ploughed in a direction crossing the last ploughing, or rather the ploughs may cross the fields diagonally, because, as it is always desirable to make each alternate ploughing cross the previous one, and as the next ploughing which forms the drills will be in the direction of the former ridges, all the ploughings will thus be made to traverse one another.

When this second ploughing is given, the land is to be again harrowed and rolled if necessary, and all the root-weeds are to be industriously collected and removed as before.

These operations will generally fit the land for being formed into drills. This may be done by single-bout drills, as in the case of the bean, or by the double mould-board plough. The distance from centre to centre, or, in other words, the breadth of the drills at the base, may be 30 inches.

A transverse section of the drills will appear thus:

Fig. 165.



When the drills are formed in this manner, the dung is to be carried forward to them, and spread in the hollows, precisely in the manner described in the case of the turnip.

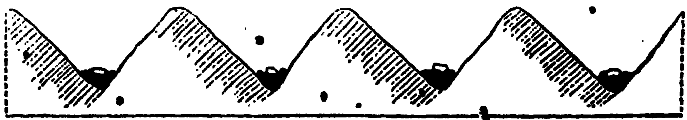
Dung will, in all cases, act the most quickly upon young plants when it is well prepared, but extreme preparation of the dung is not required in the case of the potato. It is enough that it be in such a state of fermentation as that it may be readily covered by the plough.

The potato requires a large supply of manure. The quantity should be from 16 to 20 tons to the acre, and when a larger quantity can be supplied it is well, the goodness of the potato-crop being greatly dependent upon the quantity of manure applied.

The proper manure for the potato under ordinary circumstances is common farm-yard dung. But any other putrescent manure that can be obtained may be applied. Bone-dust has been employed, and with good effects. Lime does not appear to act in a beneficial manner, and is rarely applied directly to this crop.

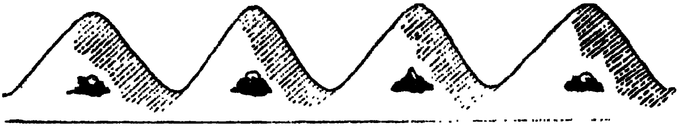
As soon as the dung is spread along the hollows of the drills, the potatoes are to be planted. The potato-sets should be cut 10 or 12 days before planting them, by which the cut part acquires a skin or indurated surface, which is supposed to protect the sets from injury when first planted. The sets are placed directly upon the dung in the row, about 10 inches from one another. The planters carrying them in baskets, gently place them upon the dung, directed by the eye, as nearly as possible at the distance required. A transverse section of the drills, with the dung and potato sets placed upon it, will appear thus :

Fig. 16



The sets are now to be covered by splitting each drill so that the top of the new drill formed is immediately above the hollow of the old one. The manner of performing the operation is the same as that described in the culture of the turnip. A transverse section of the drills when split will appear thus:

Fig. 167.



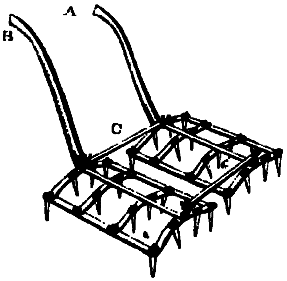
This simple series of operations completes the planting of the potato.

The usual period of planting is during the month of April, but it may be continued till the middle of May. The early potatoes should be planted by the latter part of March. The quantity planted may be from 8 to 10 cwt. to the acre, according to the size and distance of the sets.

In a fortnight or more after planting, the whole field is to be harrowed.

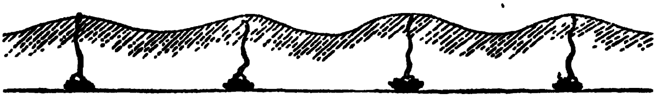
This may be done by the common harrows; or there may be used two very small light curved harrows with handles, each embracing a drill, attached to one another by hinges, and drawn by a single horse, who moves along the hollow of a drill, the workman walking behind and pressing gently upon the handles.

Fig. 168.

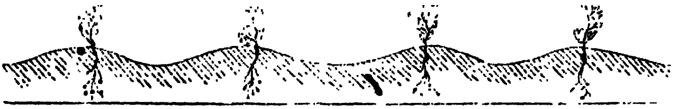


The effect of this tillage will be partially to level the ground, making a transverse section of the drills appear thus:

Fig. 169.



When the plants have got above ground, and appear distinctly in rows, the horse-hoe is to pass along each interval. This may be done by the small one-horse plough passing twice along each interval as near to the rows of plants as it can conveniently go, and throwing the earth from each row into the centre of the interval in the manner described in the case of the bean and turnip ; or it may be done by the horse-hoe with lateral coulters, passing once along each interval. Following the horse-hoe, the hand-hoers, each with the common hoe, are to hoe the rows of plants carefully, cutting up all weeds that may have escaped the action of the horse-hoe. A transverse section of the drills after this operation, will appear thus :

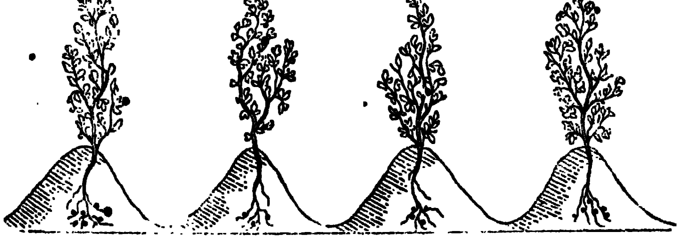


After an interval, as a fortnight or more, the horse-hoe with coulters is again to pass along the intervals. Immediately succeeding the horse-hoe, the hand-hoers are to follow as before, hoeing about the plants and cutting up all weeds.

This is generally sufficient to clean the land in an effectual manner, though sometimes, when it is exceedingly full of weeds, a third hoeing may take place.

The last operation is raising the earth to the stems of the plants. This is done by a double mould-board plough passing once along the intervals, and throwing up the earth towards each row. A transverse section of the ground will then appear thus :

Fig. 171.



This in all cases completes the culture of the potato. The plants will now grow with quickness, their stems spreading over the intervals and covering the entire ground.

Deviations from this method of culture may take place, but these it is unnecessary to detail. It is sufficient to have explained one practice, simple, cheap, and efficient, and which, under all circumstances of potato-culture in the fields in this country, can be carried into effect.

The crop requires no further attention until the tubers are ready to be taken up when ripe, which is generally in the month of October.

The operation of taking up the tubers may, upon the small scale, be performed by digging them up with a three-pronged fork; but, on the large scale, it is to be performed by the plough.

The plough, from which the coulter has been previously taken, is to pass with a *deep furrow* along the centre of the drill, and thus reverse one-half of it. It is to be followed by a sufficient number of persons to collect the potatoes into baskets. It is then to return by the same drill, reversing the other half of it, so that the whole tubers of the drill are turned up. Time is saved in this operation by the plough, after laying open the half of one drill, passing to another drill, where there is a like number of persons to follow it, and so on to another and another. It then returns to the first drill, and reverses the other half of it, and so on in succession with the other drills. Often, however, the plough reverses an entire drill at one turn. After the plough has reversed the different drills, the harrows should follow, so as to bring to the surface any tubers that may have escaped. In this manner the gathering of the potato-crop, which in many cases is regarded as a work of time and labour, is performed with economy and despatch.

Tubers intended for planting, and not for consumption, may be taken up earlier than the others, so that they may be secured before they are over-ripe.

It is important that the potatoes be taken up in dry weather and before frost. They may be preserved in various ways, the purpose being to secure them effectually from frost, and prevent them from putrefying.

Sometimes they are conveyed at once to a house, and stored in it, to be ready for use or sale. But the more frequent practice is to form them into oblong heaps, and to cover them carefully with a thick layer of straw, and this again with a coating of earth. There is no better non-conductor for this purpose than straw. When any heap is to be opened for use, bunches of loose straw should be employed to defend it from the air. Even when the potatoes are kept in houses, they should be carefully covered with dry straw, to prevent the action of frost upon the tubers.

After the potato, the usual crop sown is wheat, for which the ground is well prepared by the operations of the potato-culture.

The later and common varieties, it has been said, should be planted if possible in the month of April. The early varieties should be planted before the end of March. Under good cultivation and favourable circumstances, the latter will be ready to allow a crop of turnips or rape to be sown in the same year.

In some parts of the south of England, early potatoes are planted before winter, and are thus ready very early in the following season. They are planted in October or November, 9 or 10 inches under the surface, and well covered with litter or dung. They appear above ground in March, and are ready by the middle of May. In some cases even, by planting in October, a crop can be raised before the winter frosts set in, which is used during winter.

It has been often recommended to pinch off the blossoms of the late potatoes, so as to prevent the formation of seeds. This has been deprecated by some, but recommended in an especial degree by Mr Knight, who asserts that more than a ton of additional tubers per acre will be procured by this means. Certainly an increased produce will be obtained if the operation is performed sufficiently early. A female or a boy will pluck off the blossoms of from 1 to 2 acres in a day.

The produce of the potato varies so greatly, that it is difficult to say what may be regarded as a medium return. Generally speaking, the crops produced in England and Ireland are greater than those produced in Scotland. In Lancashire the produce is reckoned to be from 8 to 12 tons per acre. In Scotland a fair produce is held to be 8 tons per Scotch acre, which is equal to 6$\frac{2}{7}$ tons per English acre.

The starch or fecula of the potato may be obtained separately by simple means, and applied to various purposes of domestic economy. The quantity is generally from about a fourth to a fifth part of the whole weight.

This substance is perfectly nutritive, but, wanting gluten, it does not undergo the panary or bread fermentation. It is not therefore so well suited to the making of bread as the flour of wheat. It may, however, be mixed with the latter in a given quantity so as to produce good bread, and it is suited to those other purposes of domestic economy in which the panary fermentation is not required. The use of the starch of the potato has been gradually extending in various forms, by which the utility of the potato, as a branch of husbandry, is likely to be greatly extended.

The potato yields a large quantity of ardent spirits by distillation, for which purpose it is now extensively employed in the distilleries of France and the Netherlands, and to a considerable extent also. it is believed, in the distilleries of this country.

The potato may be given in its raw state to nearly all our domestic animals. It requires merely to be washed, which is done by various simple means. One of these is by a cylinder or barrel, with a wooden axle placed vertically, to which are attached upright sparred arms, like a churn. These being turned round by a handle, the potatoes in it are put in motion, and the cylinder being partially filled with water, they are washed by a few turnings of the handle. The water is let off at the bottom of a stop-cock; and when the cylinder is large, a hinge-board is made to open and shut at the side or bottom, by which the potatoes are removed. Other contrivances for washing are resorted to which need not be described. The principle of construction of them all is to give a sufficient motion to the roots when immersed in water.

But although potatoes may be given to live-stock in their raw state, and it is frequently convenient to give them in that state, yet various benefits may arise from giving them steamed or boiled. In this state they are relished by every class of our domestic animals, and afford food in a high degree nourishing and salubrious. Even the dog, which will not touch raw potatoes, will fatten upon them when boiled or steamed.

Steamed potatoes, mixed with cut straw or hay, may be given to horses of every kind, even when on the hardest work, and this forms a species of food both wholesome and economical.

They may be given in this state to dairy-cows, or to any kind of cattle for the purpose of feeding. But it is observed that steamed food is not generally attended with the same benefit to ruminating as to other animals. To hogs they are given with the best effect. When poultry is reared in quantity, their food may be considerably economised by mixing the potato with meal. An apparatus for preparing the potato for these various uses by steam has already been described (Fig. 53).

The accidents and diseases to which this plant is subject are, happily, not many, nor, in this country at least, very formidable.

Of these diseases the best known, and the most dreaded, is that which is termed the *curl*. It is indicated by the curling of the leaf, and hence the name. It seems to arise from a certain decayed vigour in the plant, which unfits it for the production of tubers. In cultivating the potato as we do, solely from tubers, we deviate from the natural habit of the plant, which tends to produce its species by seeds as well as tubers. When we cultivate solely from tubers, therefore, we do a certain violence to nature, and it may be reasonably concluded, that the vigour of the plant is impaired. To prevent this, we have the means of obtaining new plants from the seed, and thus a method of restoring their natural habits and renewing their vigour. But another mean of obviating this tendency to degeneracy has been already adverted to, namely, the selecting of tubers from plants that have not matured their seeds. The good effects of this are proved by the numerous experiments of horticulturists and farmers.

The potato is of high importance in this and other countries. Its cultivation has extended rapidly, and is yet likely to extend. It can be cultivated on the large as well as on the small scale,—by the manual labour of the peasant as well as by the plough, and with more or less success in every soil where cultivation is practicable. And it has done more than any of the cultivated plants to bring nearer to a level the value of different soils of the country; because crops of potatoes can be produced on inferior light soils and on deep peat, often equal to those of the superior loams.

5. THE CARROT.

The Carrot, *Daucus Carota*, is of the natural order *Umbelliferæ*, an extensive family, which, like the *Solaneæ*, contains species that are highly nutritive, and others that are poisonous. Of the latter class are the hemlock; of the former are various well-known esculent herbs, as the carrot and the parsnep. The tribe of *Umbelliferæ* generally is suspicious and dangerous, except that the seeds are innocent; and many of them are cultivated for the aromatic qualities of their seeds, as the coriander and others.

The wild carrot, *Daucus Carota*, is a native species, familiar as a weed, under the name of bird's nest, from the resemblance of its umbellated top to a bird's nest." By what accident this plant, with its slender fusiform root, has been changed into the plant of our gardens, is unknown. It is probable that the latter has been derived from warmer countries, and not from the wild plant of northern Europe, which no cultivation has been able to change.

Of the cultivated carrot there are many sorts, distinguished by their colour, size, and form. The most esteemed for field-culture in England are the Altringham, the Orange, and the Long-red.

The carrot, from its long fusiform root, requires a deep soil. It prefers the sandy, and rejects the stiff clays. Large crops of it are sometimes produced on a deep rich peat; but the proper soil for it is a sandy loam.

The land intended for carrots should be ploughed with a very deep furrow previous to winter, and at this period the dung should be applied at the rate, it possible, of from 15 to 20 tons to the acre. So essential is it to plough deep for this crop, that it is common to make the first ploughing a trench-ploughing, one plough following the track of the other. In some parts of the Continent the spade is made to follow the plough, in order to deepen the furrow.

In spring the land is cross-ploughed and well-harrowed, and all root-weeds are removed. It is again ploughed, and the same operations are repeated; and, if it be necessary, the ploughings and harrowings are to be given again and again, until the soil is reduced to a proper tilth, and all the vivacious roots of plants collected and removed.

The plant may now be cultivated in three ways:—

1*st*, The land may be formed into drills, and the seeds sown on the tops of them in the same manner as those of turnips.

2*d*, The seeds may be sown in rows, but without being on raised drills.

3*d*, The seeds may be sown broadcast.

When the plant is cultivated in the first of these modes, the operations of hoeing and cleaning are nearly the same as those of the turnip, the horse and hand hoe being employed in succession to till the intervals and plants in the rows. But the seeds having many hooked hairs on their surface, adhere to one another, on which account the machine for sowing them must be peculiarly constructed, so that they may be separated in sowing.

The next method of cultivating the carrot is in rows, but not on raised drills. In this case, when the land is fully prepared, the double mould-board plough is to form it into shallow drills, at the distance, from centre to centre, of 12 or 15 inches; and in the ruts or hollows of these drills the seeds are to be sown. This may be done by a sowing-machine suited to the nature of the seeds; or it may be done by the hand, in the same manner as gardeners do, mixing the seeds with a little dry sand, and rubbing them in the hand to make them separate. The seeds are then covered by a slight harrowing. This is a good method of cultivating the carrot.

The other method of cultivating the carrot is broadcast. This is practised in the Sandlings in Suffolk, where the culture of the carrot is successfully carried on, and large returns obtained. The same method is practised in the Netherlands, where the carrot is highly valued as a crop, and carefully cultivated.

Of these three methods, the best under ordinary circumstances is that of rows, either on a raised or flat surface, and these rows may either have a narrow interval, as 12 or 15 inches, in which case the hand-hoe only can act, or they may be at such a distance that the horse-hoe can also act, as in the case of the turnip and other fallow-crops.

The seeds of the carrot should be of the previous season's growth, otherwise they may not vegetate; and care should be taken in all cases to try them before they are sown, the most frequent cause of the failure of the carrot being the badness of the seeds.

The quantity of seeds may be from 2 lb. to 3 lb. to the acre, when sown in rows, and 5 lb. or more when sown broadcast. The most approved period of sowing is the beginning of April.

When the plants are fairly above ground, they are hoed to the distance of 3 or 4 inches This operation is to be performed with great care, as it is difficult at this period to distinguish the carrot from the weeds in the rows. In three weeks or more the carrots are again hoed, and set out at the distance from one another of about 10 inches. In a few weeks more, or whenever weeds appear, the operation of the hand-hoe must be carefully repeated. These three hoeings will be sufficient to complete the summer culture of the carrot.

The carrots may be taken up and stored about the end of October, or, which is better, they may be left in the ground and pulled up as required. When carrots are to be stored, they are taken up in dry weather, and their leaves cut off close to the root. They may then be put in narrow oblong heaps, the tails and heads being packed together, and the whole covered with a coat of straw. If taken up when dry, carrots will keep well in these heaps, without any other precaution than defending them from frost.

The produce of the carrot, in circumstances that are favourable to it, will be from 300 to 400 bushels to the acre, though much beyond this quantity is sometimes produced.

Carrots may be given to every species of stock, and they form in all cases a palatable and nutritious food. They are given in their raw state, though they can be steamed or boiled in the same manner as other roots.

The live-stock to which they are most frequently given is horses and dairy-cows. They are found in an eminent degree to give colour and flavour to butter, and when this is the end to be aimed at, no species of green-feeding is better suited to the dairy. To horses they may be given mixed with cut straw and hay, and thus given, they form a food which will sustain horses on hard work. They afford excellent feeding for hogs, and quickly fatten them. When boiled they will be eaten by poultry, and, mixed with any farinaceous substance, form an excellent food for them. They may be used for distillation, affording a good spirit.

Although the return of this crop is, on soils and situations suited to it, very valuable, it is only in certain situations that it can be beneficially cultivated, and for this reason it is that it does not form an object of general interest in the agriculture of this country. Where circumstances admit of its being introduced into the rotation, the essential points to be attended to are, that the soil on which it is grown shall be deep and of the lighter class, that the tillage shall be deeply given, and that the seeds shall be fresh and of the proper kind.

THE PARSNEP.

The Parsnep, *Pastinaca sativa*, in its uses, and the manner of cultivating it, resembles the carrot. It is a native of many parts of Europe and of Asia. The wild plant has a slender root, with downy leaves: in the cultivated variety the leaves are smooth, and the root large and mucilaginous.

The most extensive cultivation of the parsnep in this kingdom is in the islands of Jersey and Guernsey. The large Jersey parsnep is the kind most approved of for cultivation, whether in the garden or the field. It grows freely on the deep disintegrated gneiss of these islands, sometimes extending three or four feet into the soil. There are two kinds of it, one of which is fusiform, and strikes deeply into the earth, the other becomes thick and tends to the napiform.

The seeds of the parsnep may be sown either in autumn or in spring. The latter period is generally adopted, but the autumnal sowing is well suited to the habits of the plant.

When it is to be cultivated in spring, the land intended for it is to be ploughed in autumn with a deep furrow. It is to be cross-ploughed in spring, and tilled and cleaned, in so far as the earliness of the season will allow; for the parsnep must be sown at an early season, the common period usually being the month of March.

The parsnep may be sown on a flat surface, in rows, like the carrot, the plants being kept at a somewhat greater distance from one another. But sometimes the seeds are sown in beds in autumn, and transplanted when the soil is prepared.

The parsnep might also be cultivated in drills precisely like the turnip and potato. Nay, this seems to be the best mode of raising it; because an increased deepness eminently favourable to the habits of the plant will be given to the soil. If cultivated in this manner, the drills may be no wider than is necessary to admit the horse-hoe, as 24 inches; and the plants may either be planted in the drills from previously sown beds, or the seeds sown in the manner of the turnip, and hoed out to a distance of 8 or 10 inches from one another. The method of transplanting would probably be the better, as in this case the plants would not need to be planted in the drills till the month of April, when the land could be better prepared.

All the after processes of tillage may be the same as for the carrot.

The seeds must be new, because when they are more than one year old they frequently do not vegetate. The seeds are very light, but they do not adhere in the same manner as the seeds of the carrot, and hence are more easily sown.

The parsnep has a wider range of soils than the carrot, and unlike the carrot, seems to prefer those which are more or less clayey.

The plant is ready for use when the leaves begin to decay. It may be taken up and stored like the carrot, or left in the ground to be pulled when required for use. It is not apt to be injured by frost; but it should not be left in the ground after the beginning of February, because, as soon as the flower-stalks begin to form, the roots become hard. The produce is generally greater than that of the carrot.

Its uses for domestic purposes are well known. It is a useful esculent for the garden of the cottager. When persons abstain from animal food, as in Catholic countries, the parsnep is regarded as a grateful substitute. For this reason it is that it was formerly more cultivated in this country than now, to be eaten with salted fish during the season of Lent; and it is yet largely cultivated for the same purpose in the north of France and the Low Countries.

All animals are fond of the parsnep. To milch cows it is eminently favourable, giving a flavour and richness to their milk which no other winter vegetable but the carrot can give. The cows of Jersey and Guernsey fed with parsneps and hay yield butter during winter of as fine a tinge, and nearly as good flavour, as if they were fed in pastures. To horses it is equally suited as the carrot. Hogs are extremely fond of it; and, when boiled, poultry may be fed upon it.

Like the carrot, it yields a large quantity of spirits by distillation.

As a plant of agriculture, the parsnep seems to be better suited to general cultivation in the field than the carrot, as being more productive, and having a wider range of soils. At the same time, from the early period at which it must be sown, and from the difficulty of getting the land fully prepared for it in spring, it cannot be said to be a plant well adapted to field-culture in this country. It is, however, suited for being cultivated on the small scale, and in this view it is better deserving the attention of the cottage-gardener than other plants which have succeeded to it in common estimation.

7. The Beet.

This plant is of the natural family *Chenopodeæ*, several of the species of which are known to the farmer as weeds, while others are cultivated for their roots and leaves.

The field-beet, *Beta vulgaris*, is of larger size, and grows more above ground, than the garden kinds. It is sometimes red externally, and yellowish-white internally; but it has different shades of colour. It is frequently called Mangel-Wurzel, from the German, and has sometimes received the name of the Root of Scarcity. The introduction of the mangel-wurzel into the agriculture of this country is of comparatively recent date. It was cultivated in Germany long before it was introduced into this island.

In Belgium and Alsace, in the Palatinate of the Rhine and other parts of Germany, the most common method of culture is to sow it in beds, and to transplant it into lines. But it may be cultivated also in a manner similar to the turnip.

The land intended for this crop is ploughed before winter, and as early in spring as the labours of the farm will allow it is ploughed across. It is then well harrowed, and rolled if necessary, and the root-weeds are collected and carried away. It is again ploughed, harrowed, and rolled, and formed into drills, if it should be in a fit state; or, if not, the ploughing and harrowing are repeated till it is so.

When it is formed into drills, the dung is carried to the land and covered by the splitting of the drills, as in the case of the potato and turnip. The quantity applied should be liberal.

The seeds are large, and stick a little together. It is therefore frequently found convenient to sow them by the hand, in the same manner as the seeds of the carrot are usually sown.

Sometimes the seeds are dibbled in, shallow holes being made for their reception by the dibble, into which a few seeds are dropped. This is a tedious process, and does not appear to possess any advantage over a continuous sowing in ruts made upon the top of the drill.

The seeds should be fresh, not exceeding one year old, and the utmost care should be taken that they are of the true kind, for great loss would be sustained should any of the smaller garden sorts be sown. The period of sowing may be about the middle of May, or earlier.

When the plants are fully above ground, the horse-hoe with coulters, or the single-horse plough, is to pass along the intervals. Immediately afterwards the hand-hoers with the common turnip-hoe, are to thin out the plants to the distance of 8 or 10 inches.

After an interval, when the weeds are again springing up, the horse-hoe is to pass between the rows; and after this the hand-hoers are to follow, cutting up all the weeds in the same manner as in the turnip-culture.

The next process is the setting up of the earth to the roots, which may be done by the double mould-board plough. This completes the summer-culture of the beet.

Before the setting in of winter frosts, the beet may be pulled up and stored. The stems are cut off by a stroke of the knife, care being taken not to wound the root, which is peculiarly susceptible of injury. The leaves furnish excellent food for every kind of live-stock. On the Continent it is common to cut off the leaves of this and such plants as the carrot, the parsnep, and Swedish turnip, while growing. This is a point of economy little attended to in English agriculture. With respect to the practice, it is to be observed, that in no case should it be attempted until the root has attained its full size.

The roots, when taken up, may be piled in an oblong heap and covered with straw. They should be taken out when required at one end of the heap, and this end carefully covered again with straw to exclude frost. The roots of this plant, it is to be observed, are greatly more susceptible of injury from frost than the Swedish turnip or the carrot.

Very large returns are occasionally obtained from beet; and it differs from the turnip in this, that it may be grown on stiffer soils. The beet, however, requires a somewhat favourable climate. It is accordingly more cultivated in the southern than in the northern parts of this Island. Although in Scotland very good crops of the beet are occasionally produced, the plant is not so well suited to cultivation there as the Swedish and yellow turnips; while in the southern counties the beet is probably a more productive crop than the turnip. Thus also in France and the warm countries of Europe, the turnips are not generally to be compared with the crops which are produced of beet.

The beet is well suited for feeding milch cows, being exceedingly nutritious, and causing them to give abundant milk, while it does not taint it with the bad flavour which turnips give.

Beet is cultivated in different parts of the Continent for distillation; and in France it is cultivated largely for its sugar.

8. THE JERUSALEM ARTICHOKE.

This plant, *Helianthus tuberosus*, is, like all the plants of the Sunflower genus, a native of the New World. It was highly esteemed by our ancestors for its tubers, but it has fallen into neglect since the more extended cultivation of the potato and other plants.

Although believed to be a native of the warmer parts of America, it is one of the hardiest of our cultivated plants, very productive, easily propagated, and growing on the poorest soils.

This plant produces stems from 5 to 10 feet in height. It does not ripen its seeds in this country, but may be propagated with the greatest ease from tubers, like the potato. It grows rapidly, and may be cultivated like the potato, but the intervals between the plants and rows should be larger. It may be planted also in autumn; but if planted in spring it will be ready in September. It is common with some to cut the stems over in July, to prevent their falling down. On the Continent the leaves and stems are used as green and dried fodder; but in England, it is believed that they have not been so employed. The tubers are in clusters attached to the roots of the plant. As compared with the tubers of the potato, they are watery, and may be believed to be inferior in nutritive properties. But the quantity is frequently very large; about 500 bushels per acre, it is said, having been produced without manure. The tubers do not seem to have great fattening properties, but they are eagerly eaten by animals.

The plant is in a peculiar manner fitted to grow under the shade. It can therefore be cultivated in woods; and it is sometimes so grown in England to afford shelter for game; the plants being left to reproduce themselves annually from tubers.

Taking into account the hardy qualities of this plant, its productiveness and easy culture, it may be doubted whether it merits the universal neglect into which it has fallen. Granting its inferiority as an article of food to the plants now cultivated for our domestic stock, it must be of some importance to have a plant that can be so easily raised, and on soils so low in the scale of fertility.

III. PLANTS CULTIVATED FOR THEIR FIBRES FOR THREAD.

1. FLAX.

The plants chiefly cultivated in the north of Europe for their fibres for thread, are Flax and Hemp.

More than 70 species of the genus *Linum* are enumerated by botanists. They are of a natural order of plants, the *Lineæ*, distinguished by the tenacity of their fibres, the mucilage of their seeds, and generally by the beauty of their flowers. The most important of the genus is

Linum usitatissimum—Common Flax.

It is an annual plant, growing with a slender upright stem, branched near the top. The fibres of the bark of this plant have been applied to the making of cloth from the remotest ages.

Being a native plant, it is sufficiently hardy to endure the climate of this and other northern countries. It has, indeed, a wide range of temperature, being cultivated, and for the like purposes, from Egypt almost to the polar circle.

Flax is an exhauster of the soil and farm, and more so when its seeds are permitted to arrive at maturity. When pulled green its effects are less injurious; in which respect it follows the general law of other cultivated plants. But still, at whatever period reaped, it is thus far an empoverisher of the farm, that its stems yield no return in manure, and that its seeds only do so when consumed upon the farm.

The soils best suited to flax are those which contain a large proportion of vegetable matter. The stiff poor clays, and the inferior soils of a very dry and gravelly nature, are not well suited to it. The best flax-soils in England are a few rich alluvial districts, in which it is still largely cultivated, and where it forms a regular part of the course.

In a rotation of crops, the best period for the introduction of flax is soon after the land is broken up from grass. For this reason it may be the first crop taken after grass or clover-lea, in which case the flax is a substitute for a crop of oats in the course. But it is not necessary that flax should be grown immediately on the breaking up of grass-land. It may be sown at any period in the rotation, provided the land is in a fertile state. But in all cases it is to be regarded as an exhausting crop, and not as equivalent to a restorative one; and these principles being attended to, the period of the rotation in which flax should be introduced will be understood.

Should the soil, for example, be suited to the four years' course, the rotation may be: 1. Turnips, rape, or other green-crop; 2. Barley or wheat; 3. Sown grass; 4. Flax.

Or the order in which the flax is introduced may be changed, and the course may be:—1. Turnips, rape, or other green crop; 2. Flax; 3. Sown grasses; 4. Oats or other corn-crop.

Under the latter course the seeds of the clovers and grasses are sown with the flax, in the same manner as with the cereal grasses; and for this purpose the flax is equally well suited.

Flax may be sown also after a pulse-crop; but this is not usually a good preparation for flax, the land being apt to become foul when the flax is preceded by a crop of beans or pease. It is better to make it succeed either the grasses, or such crops as potatoes, turnips, carrots, beet or rape.

It is common, indeed, to make it succeed to a crop of corn. But this is an erroneous practice, for after a corn-crop, which has already rendered the land foul, a crop of flax tends to aggravate the evil. Sometimes, however, not only does the flax succeed a crop of corn, but it is succeeded by another. This practice is opposed to all the principles of a proper rotation, and should be proscribed wherever the flax-culture is practised in this country.

In warmer countries the flax admits of being sown before winter, but in the north of Europe the proper period of sowing is spring.

When land which is in grass is to be prepared for flax, it is always to be ploughed in the winter-quarter, as if it were intended for oats, and as early as convenient, so as to receive the influence of frost to pulverize it before sowing. One ploughing only is required in this case; but the land should be very thoroughly pulverised by harrowing just previous to the seeds being sown.

When flax is sown after potatoes, turnips, carrots, rape, or beet, the land is to be ploughed immediately upon the removal of the crop. One ploughing is in these cases generally held to be sufficient, but the land, previous to the seeds being sown, is to be well harrowed, and rendered quite smooth.

The period of sowing in this country, is in the month of April, and in the more northern parts from the middle to the end of April is considered to be sufficiently early.

The universal method of sowing flax is broadcast. It might be sown, indeed, in rows like any kind of corn. But in the case of corn, the design is to produce a large quantity of seeds, whereas in the case of flax the chief purpose is to produce long stems. And the broadcast system is better calculated to cause the plant to rise with a straight stem than the system of rows, which affords it space to branch out: for it is to be observed, that it is not desirable that the plant should branch: because, when there is a branch, the continuity of the fibre is interrupted, and more refuse is produced. When we are desirous to obtain fine fibre, we must sow thick. When we look for quantity, both of fibre and seeds, we must sow more thin. In the former case, 3 bushels to the acre may be sown; in the latter, 2 will be sufficient.

The seeds are sown by the hand in the same manner as corn. Were the flax cultivated in quantity, the broadcast sowing-machine might be substituted. Previously to sowing, the land should, in all cases, be well harrowed and rendered fine, and any stones that may have come to the surface removed. After the seeds are sown, they are to be covered by a double turn of light harrows, and the land is then to be rolled and carefully water-furrowed.

In the culture of flax the changing of the seeds is considered to be beneficial and even necessary, the plant being found to degenerate when produced from seeds frequently sown on the same ground. The principal reason of this appears to be, that the plant is rarely suffered fully to mature its seeds, and its natural habits are counteracted by the closeness with which it is sown. It is from the countries, therefore, in which attention is directed to the proper ripening and preparing of the seeds, that we are indebted for our supplies. The best seeds used in this country are supposed to be derived from Holland; but the Dutch themselves obtain their supplies from Livonia, Courland, and other parts of the north of Europe, where due attention is paid to the ripening of the seeds.

When the plants of flax are about 4 inches high, they are to be carefully weeded by the hand. This is generally done by persons in a sitting or kneeling posture. They advance gradually along the ridges, picking up by the hand every weed that can be observed. The young plants that have been pressed down by the weeders in this operation soon regain their upright position; but yet it is well that the weeding process be not too long delayed, lest the stems of the young plants be broken and injured.

The land, if it has been prepared in a proper manner, will not require more than one thorough weeding of this kind. After weeding, the plants will grow with vigour sufficient to overcome any common weeds that may grow amongst them.

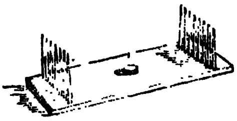
The next process in the culture of the flax is that of reaping. This is done, not by the sickle or scythe, but by pulling the plants up by the roots.

The period of pulling the plant is determined by the principal end in cultivating it. When it is wished to procure fine fibre, the plant should be pulled when somewhat green. When it is wished to procure the seeds either for sowing again or for crushing for oil, the plants must remain until the seeds are ripe. This will be denoted by the hardened state of the seed-vessels, the yellow colour of the stems, and the falling off of the leaves. When flax of good quality, but not extreme fineness, is wanted, the best period of pulling is just when the plant has attained its maturity with respect to its formation, but not to the full ripening of the seeds. When it is required for the finest fabrics of all, as for cambrics and muslins, it should be pulled when it begins to flower.

When the crop is ready, the plants are pulled up by the roots, and laid in handfuls alternately crossing one another, and left upon the ground for a few days to wither. They are then freed from the capsules or seed-vessels, and made into small sheaves, which are conveniently tied by a few stems of the plants themselves, or by some rushes or straw-ropes.

The separation of the seed-vessels from the stems is performed by a process termed rippling.

Fig. 172.



The rippling machine is an implement like a comb, with iron teeth, fixed upon a plank. Through these teeth the stems are repeatedly drawn by the hand, and thus the capsules or seed-vessels are separated. The ripple is placed in the middle of a large sheet of canvass spread upon the ground. There may be two sets of teeth, as shown in the figure, fixed on one plank, so that two persons may work at the same time; and the plank may be conveniently fixed in the ground by a pin passed through it. The capsules are preserved, the seeds being either used for sowing or bruised for oil.

The next process is to separate the fibres from the stem. The common method of doing this is by steeping the whole plant in water. By this mean the softer part of the stem partially undergoes the putrefactive fermentation, while the tougher fibres of the bark are not effected. At a certain period then, as 10 or 12 days before the fibrous part of the bark has become affected, the plants are removed from the water and dried. After being dried the stems become brittle, and are easily separated by rubbing or beating from the fibrous part of the bark, which is the only part employed in the manufacture of linen. It will appear that, if the putrefactive process shall proceed too far, the fibrous as well as the more mucilaginous part of the bark may be effected. It is, therefore, a point of practice, to allow the putrefactive process to proceed just the length of affecting the softer part of the stem, without acting upon the fibrous part of the bark. And the usual manner of performing the process of steeping is the following:

The little sheaves made up after the process of rippling, are carried away to a pool or tank, either containing water, or into which water may be conveyed: and in all cases the water ought to be soft.

The sheaves should be built in the pool in a nearly upright position, the heads of them being uppermost. They are then kept under water by stones or heavy substances of any kind, in such a manner as that they shall not rise to the surface. They must not, however, be compressed to the bottom, but merely so loaded as that they shall be kept below water.

The period of steeping to the proper point must be carefully watched. In warm weather 8 days will sometimes suffice, in other cases 10 or 12. After the sixth or seventh day, the state of the flax must be observed from time to time. It is safer to steep it too short a period than ever so little too long. In the first case, merely a little more time is required in the future processes; in the second the strength and texture of the fibres may be injured.

When the flax is found to be sufficiently steeped, it is to be taken from the pool sheaf by sheaf, and laid in heaps near the watering-place until the water has drained off. It is then to be carried away to a dry and airy grass plot. Here the sheaves are opened out and spread thinly and evenly in rows upon the ground, the spreaders working backwards, and causing the but-ends of one row just to touch the tops of the next, so that the whole plot of ground shall be covered with a thin coating of flax.

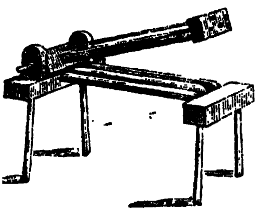
In this state the flax is allowed to lie for a time, determined by the state of the weather, generally 10 or 12 days, and sometimes more.

During the further process of rotting, or *dew-rotting* as it is termed, the dissolution of the soft part of the stem is still further promoted, and the whole becomes hard. When it has lain for a sufficient time, which is known by its being brittle when rubbed, and when it is at the time sufficiently dry, it is bound up again into sheaves, but larger than those made before the watering process. It is allowed to remain in these sheaves a little time to dry, after which it is carried home.

The carrying home of the flax terminates the preparation, in so far as the mere grower is concerned. The remaining parts of the operation are properly the province of the manufacturer. But sometimes the manufacture proceeds on the farm itself to the extent of partially separating the fibrous part.

The first process in this case is breaking the stems, which is usually done by an instrument called a *break*. This machine consists of three triangular planks, fixed together at both ends. Two triangular planks are fixed to another frame. The two frames are fixed together at one end by a hinge, and work the one into the other, as in the figure.

Fig. 173.



The upper moveable frame being lifted up, handfuls of flax held in one hand are placed upon the lower frame, while with the other hand the upper frame is made to work upon the flax by repeated strokes. In this manner the flax is bruised, and put into a state to have the ligneous refuse separated from the fibrous part by beating or scutching.

Scutching may be performed either by machinery or by manual labour. When performed by manual labour, handfuls of the flax being suspended by one hand over a plank, are beat by a flat piece of wood held in the other hand. By repeated strokes, the woody refuse of the stem is separated from the fibrous part of the bark. But the operation of scutching is now very generally performed by machinery, the raw material, after being bruised by the break, being sent to the lint-mill for that purpose.

To complete the process, and to get the fibres sorted into lengths, so as to be fitted for spinning, the lint goes to a class of persons whose province it is to give it this final preparation.

These are termed hecklers. The heckler operates by means of a set of numerous teeth, placed vertically upon a board. The flax is pulled repeatedly by the hand through these teeth. In this way, and by using heckles of different sets of teeth, the workman sorts the lint into lengths. The refuse after this operation is tow.

The produce of flax varies greatly with the seasons, soil, and management. It may be said to be from 30 to 60 stones per acre, that is after being scutched, and before being combed or heckled.

Besides the produce of the plant in lint, that of its seeds is of considerable importance. The quantity of seeds produced on the acre varies as greatly as that of the produce of the stem. It may be said to be from 6 to 10 or 12 bushels to the acre.

The seed is frequently divided into three sorts: the first sort is reserved for seed, the second for bruising for oil, and the third or refuse is employed at once for the feeding of cattle.

The capsules containing the seeds, we have seen, are separated by the ripple. The ripple is carried to the field, and the operation takes place before the handfuls of the flax are bound into sheaves to be carried to the watering pool.

The capsules are then dried in the sun, during which a number of them will open, and allow the seeds to escape. These are the best and ripest, and may be reserved, if so wished, for sowing.

The remaining seeds are separated from the capsules by a slight beating. The seeds are then carefully sifted and winnowed, and laid in some properly ventilated place, care being taken to turn them from time to time.

The expression of the oil by bruising is a sufficiently simple process, and is done by machines more or less perfect.

The refuse of the seeds may be given to live-stock. They are highly nutritive in every form. They are frequently given boiled to young animals, as calves, and to sick horses and cows. By the process of boiling, a jelly is formed, which all herbivorous animals will eat. It is for this purpose that the refuse of the seeds of the flax, which are not sufficiently good for crushing, is often reserved.

The culture of the flax does not extend in this country, and has generally decreased as improvements in agriculture have advanced. This arises in part from the nature of the plant, the minute care necessary in its culture, and the large supply of extraneous manures which it requires. It arises, however, also, in a great degree, from the extended commercial relations of England, which enable her to obtain the quantity of the raw material required from countries better fitted to produce it, or where the comparative expense of labour is less. Flax, it has been said, requires a large proportion of vegetable matter in the soil. Sometimes, for this reason, peaty soils will produce it in great abundance; but the best flax-soils are those rich vegetable grounds which exist in new countries, as over all the temperate parts of America, and even in the north of Europe, and chiefly upon the flat margins of rivers enriched by deposites of mud. These are the great flax-soils of the world, and may supply this country with the material, for the uses of the arts, in any quantity that may be required. The best cultivators of flax in Europe are the Flemings, amongst whom the linen manufacture took early root, and who have ever since pursued the culture of flax with diligence and success.

2. HEMP.

Hemp, *Cannabis sativa*, is of the natural order *Urticeæ*, the Nettle tribe, many of the species of which, like the hemp, are remarkable for the tenacity of their fibres. Even the common nettle, familiar to the farmer as a weed, possesses this property.

The hemp is supposed to be of eastern origin. It is very generally diffused over the world, and has been used for supplying cordage and cloth for a period unknown.

The hemp is a very fine and graceful plant. It is diœcious, that is, the male and female flowers are produced on different plants. It grows with us, in the fields, to the height of 5 or 6 feet, but in the richer soils of warmer countries it attains to a much greater elevation. In the fertile plains of Lombardy it rises to the height of 12 feet and more; and, mingled with the maize and other cultivated plants, gives an air of surpassing richness to the landscape.

The leaves of the hemp are powerfully narcotic; its seeds are nourishing, and are eagerly consumed by birds; and they produce an oil which is used for many purposes of the arts.

But the great use of hemp is for the making of cordage and canvass. For this, its tough, durable, and elastic fibres are suited beyond any other substance. The supply of hemp for the cordage and canvass of the shipping of this country is immense, and forms a vast trade with the ports of the Baltic. But, besides being used for the canvass of sails, sacks, and other coarser fabrics, hemp is employed in forming numerous cloths used in domestic economy, as towels, coarser table-cloths, and the like.

Hemp, like flax, prefers a rich vegetable soil, but it is not at all nice in the choice of soils, growing in clay, sand, or peat, provided merely the land is kept rich with manures. Hemp, too, possesses the anomaly of growing upon the same spot for successive years without degeneracy.

For hemp the land may be prepared in the same manner as for flax. But hemp, unlike to flax, may precede or follow a crop of corn in the rotation; and the reason is, that while flax invariably renders the land more foul, the tendency of hemp is to smother and choke all other plants. Grass-seeds, too, cannot be sown with hemp, because they would be destroyed under the shade of its thick foliage.

Hemp may be introduced into the rotation in such a manner as the following:—1. Fallow or green crop; 2. Wheat; 3. Sown grasses; 4. Hemp; 5. Oats. Or, 1. Fallow manured; 2. Wheat or other corn-crop; 3. Sown grasses; 4. Oats: 5. Hemp manured; 6. Corn-crop. Or, in very rich soils, hemp may follow hemp, provided the land is largely manured every second year.

The land intended for hemp should always be ploughed in time to receive the influence of frost; and when it follows a corn-crop, besides a deep ploughing before winter, it should receive two or more ploughings in spring, so as to reduce the soil to a fine tilth, and free it of root-weeds.

The period of sowing hemp is later than that of sowing flax, for it is more easily injured by the frosts of spring. It may be sown towards the end of April, or beginning of May.

The best seeds are held to be those obtained from Riga; but wherever the seeds are procured, care must be taken that they be fresh, which will be known by their being heavy and bright in the colour.

The quantity of seeds sown to the acre is generally from 2 to 3 bushels, and the common method of sowing is broadcast. But hemp is well suited to be sown in rows, this method of cultivating it presenting the advantage of allowing the intervals to be well tilled, and of admitting air to the plants.

The distance between the rows may be 30 inches. The horse and hand hoe may be both employed. In the first hoeing, the plants should be hoed out to the distance from one another of a foot in the rows, and after the interval of a month or six weeks, another horse and hand hoeing should be given, which will complete effectually the summer culture of the hemp.

But the common practice in the hemp districts is to sow broadcast, hoeing the plants to the distance from one another of a foot or 16 inches, and giving another hoeing after an interval of a month or six weeks. There are other districts, again, in which it is common to give no other culture than to pull up the larger weeds, trusting to the rapid growth of the hemp to overtop all kinds of plants.

As the season advances, the hemp grows with great rapidity, and in autumn it is pulled up. But the circumstance of the male and female flowers being on different plants gives rise to a peculiarity in the method of treating the hemp which exists in the case of no other of our cultivated plants.

The male plants are distinguished from the female by their producing numerous flowers. These, after they have stood sufficiently long to discharge their pollen, are pulled up, the female plants being allowed to stand for several weeks longer, to ripen their seeds. The period of pulling the male plants is generally five or six weeks before pulling the female or seed-bearing plants. Thus there are two harvests of the hemp, the one five or six weeks before the other.

When the period of pulling the male plants arrives, which is denoted by the forming of the seed upon the female plants, the pullers walk between the drills, when the row-system is adopted, and, when the broadcast is used, in the furrows between the ridges, and stretching across, pull up the stalks, taking care not to tread upon or break down those that are to remain. The male plants are easily known at this time by their yellowish colour and faded flowers. When pulled, they are tied in small bunches, previous to being carried to the pool to undergo the process of steeping, as in the case of flax.

The second pulling takes place when the female plants have matured their seeds. This is known by the brownish colour of the capsules, and by the fading of the leaves.

The plants are then bound in bunches and set up on end to dry, in the same manner as sheaves of corn. When the whole are so dried that the capsules can be easily rubbed from the stalk, the sheaves are slightly thrashed, and thus the capsules are separated from the stems.

When this is done, the plants are taken in small bunches to the pool to be steeped.

The male plants, we perceive, undergo the process of steeping before the female plants. The manner of performing it is in both cases the same. But often the female plants do not undergo the process of preparation in the same year, but are stacked, so as to be prepared in the following spring and summer.

As it is in some cases necessary to economise the water used for steeping, the water of one pit or pool is made to serve the purpose of successive waterings. Sometimes five waterings take place in the same pool; but there should not, if possible, be more than three without the admixture of fresh water, since the fresher the water is the better.

The bunches are generally placed in the pool in rows, crossing one another, and pressed down by some heavy substance laid upon them, so as to be kept from rising to the surface, care being at the same time taken that they are not so loaded as to be forced down to the bottom. If the weather be warm, 4 or 5 days will frequently be sufficient; if not, 2 or 3 more; but the period is denoted by the stem being so softened that the outside coat shall come easily off. Care must be taken, as in the case of flax, that the putrefactive process does not proceed so far as to injure the cortical fibres. The quantity put into one pool may be the produce of an acre: but it is better that the quantity be small and the pits shallow.

When the hemp is thus steeped, it is, like flax, taken out of the pool and carried away to a plot of sward, on which the plants are spread singly and regularly.

The hemp thus spread out, lies 3, 4, or more weeks upon the surface, and is turned over not less than twice a-week. It is thus subjected to the further influence of the rains and dews, and the decomposition of the ligneous part of the stem is promoted. By this process the stem becomes hard and brittle.

When the hemp is seen to be in a state for removal, it is taken from the ground, bound into bunches, and carried home to the barn, where it undergoes the process of bruising by the machine called a break, as in the case of flax.

When thus prepared it is bound up in bunches, generally weighing a stone each, and carried to market. The hemp which breaks off in the operation is technically termed shorts; and is half the value of the long hemp. The refuse is used as fuel.

Often the steeping process or water-rotting is omitted, and the hemp is simply dew-rotted. Thus, when the female plants are not immediately prepared, but are dried and stored up during winter, they are not put into the steeping pool, but spread on the sward early in the next season, as in January or February, regularly turned, and exposed for a sufficient time to the influence of the weather. In this manner the necessary decomposition of the stem takes place; but it is always better to hasten the fermentive process by steeping, the texture of the hemp being injured by too long exposure.

After the hemp has undergone the operation of breaking, it passes into the hands of various artisans.

The first operation is that of heckling; which is done either by the hand or by machinery. The hemp is first beat, and then dressed by means of fixed heckles, resembling those used for flax. It is arranged into sorts, finer or coarser, to suit the demands of purchasers. It then passes into the hands of the spinner, of the whitster, as he is called, of the weaver, and of the bleacher.

The produce of hemp in rough fibre, that is before heckling, varies from 30 to 50 stones and upwards per acre. It leaves a large return when the crop is good, but the expense of labour in all cases is large.

The quantity of seeds produced is not less various than that of the fibre; 10 or 12 bushels to the acre are considered as a medium produce, but this quantity is often considerably exceeded.

It is a question in the case of hemp, as of flax, how far it is expedient to extend its cultivation in this country. In many cases, certainly, hemp might form a profitable subject of culture. It is held to be a good paying crop in the districts where it is yet raised, and in many cases the first crop of hemp raised from peaty soils might be found more than the fee-simple of the ground. But yet, as an object of general culture, it does not appear that much public or private benefit would result from an increase in the production of hemp. It is a plant that requires a large supply of manures, not always easily obtained, and a degree of minute labour not always consistent with the regular business of a well-ordered farm. It can be obtained, too, in unlimited quantity from other countries; and it appears that the home cultivation of it has diminished as the commercial relations of the country have been multiplied and extended.

Of the textile plants of Northern Europe, greatly the most important are the flax and hemp.

Numerous plants, however, yield fibre of sufficient tenacity for forming threads. Some of these have been partially cultivated, or made the subject of experiment.

Many of the nettle tribe, as well as the hemp, yield tough and durable fibres. The common nettle *Urtica dioica*, might be used for this purpose.

Urtica nivea, the Chinese or White-leaved Nettle, is a native of China, Japan, and other countries of the East, where it is used for making cordage, and sometimes thread. No satisfactory experiments are recorded of the culture of this plant in Europe.

The Siberian or Hemp-leaved Nettle, *Urtica cannabina*, is a native of Siberia, whence its seeds were brought to St Petersburgh, and dispersed over Europe. No conclusive experiments upon it, as the subject of culture, seem to have been made.

Urtica canadensis, and others of the genus, have been proposed for use; but experiments upon them as the subjects of useful culture, are entirely wanting.

Asclepias syriaca, Syrian Swallow-wort, is one of the textile plants. It is a native of Canada, though termed Syrian. In Canada it fills the woods with its fragrance when in flower. Its seeds are surmounted by tufts of silky down, which can be used like cotton. This plant, though long known in England, has never been cultivated for economic uses. It is perennial, and may be planted in rows. Its habit is to send forth numerous shoots, and in the third year these will have covered all the ground. Independently of the down of its seeds, the bark of the plant yields fibres like the hemp, and, it is said, more abundantly. It has been partially cultivated in France; in some parts of which it may be said to be naturalized. Its cultivation has made some progress in Silesia. How far it could be advantageously introduced into the agriculture of the north of Europe is not yet known.

Various common plants yield fibres of sufficient toughness to be made into thread; as the Esparto Rush, *Stipa tenacissima*, which is used in Spain for obtaining coarse thread; the Common Broom, *Cytisus scoparia;* the Spanish Broom, *Spartium junceum;* different species of Aloe, and several plants of the Lily tribe.

Phormium tenax, Iris-leaved Flax-lily, sometimes termed New Zealand Flax, has recently attracted attention for the uses of its fibres. This plant grows with broad, stiff leaves, like plants of the lily tribe. It is found in New Zealand and Norfolk Island, where its fibres are converted into threads, fishing-lines, cloth, and mats. It has since been used for cordage for ships, and it is found to be well suited for the purpose; and it has recently been manufactured into various coarse fabrics in this country. It has been long grown in gardens in England: and, in the south of Ireland, some attempts were made to cultivate it for use. The iris-leaved flax-lily, however, requires a warmer temperature than we possess in these islands.

The warmer regions of the world abound in plants possessing a fibrous structure of the bark, which renders them capable of being employed in the making of ropes, thread, and cloth.

Other plants produce a down which envelopes their seeds. Of these, greatly the most important, and now an object of vast consumption, is the Cotton plant *Gossypium.* This is the plant of warmer countries, and can only be known in the colder parts of Europe as the subject of commerce. The warmer parts of the temperate zone, and also the intertropical regions of America, Asia, and the accessible parts of Africa, can furnish us with the down of the cotton seeds in unlimited quantity.

Several native plants furnish a pappus or down which, it has been supposed, might be converted into cloths. The down of some kinds of *Eriophora*, or Cotton-grasses, the produce of our bogs and heath soils, has been manufactured into cloth, and exhibited in the country as curious native productions.

IV. PLANTS CULTIVATED FOR THEIR OILS.

The plants usually cultivated in the north of Europe for their oils, are—

1. The Rape, and other plants of the Cabbage genus.
2. The Mustard, the Raddish, the cultivated Camelina, and other Cruciferæ.
3. The Hemp and Flax.
4. The Poppy.

The oils which these plants yield are obtained by bruising their seeds, and are termed Fixed Oils. There is another class of oils obtained by distillation, termed Volatile Oils. These last are yielded in an especial manner by plants of the Mint family; but the plants producing them are rarely the subjects of cultivation on the large scale.

Of the oil-bearing plants of the north of Europe, the most extensively cultivated are the fusiform varieties of the genus Brassica, namely,—

1. Brassica Napus—Rape or Cole.
2. Brassica campestris—Navew, Rape or Colza.
3. Brassica Rapa—Turnip.
4. Brassica præcox—Early Cole.

The two last species are only partially cultivated for their oils; the two former are regarded as the most important of our oleaginous plants.

The manner of cultivating these plants for their leaves has been described, and there is no other difference in the manner of cultivating them for their seeds, than suffering them to stand until they are ripe. The turnip and early cole will usually ripen their seeds in the same year, and so will the other species, if sown sufficiently early, and if the produce of spring-sown seeds is sown; for these, like other cultivated plants, acquire the habit of late or early ripening, according to the period at which they are habitually sown. The proper period, however, of sowing the seeds of the rape in this country is in summer or autumn, that they may ripen their seeds in the following summer. They are to be kept clean by horse and hand hoeing in the first year; they will be in flower in the May of the following year, and in July the seeds will be ripe.

The plants are best reaped by the sickle, and the operation is to be performed with care, so as to prevent the loss of seeds by shaking. The plants may be bound into bunches, and placed in stacks until it is convenient to thrash them. But it is better to thrash them as soon as they are dried. This may be done in the field, if the weather is good, by thrashing on boards, with sheets of canvass spread underneath; or the crop may be carried home to the barn and thrashed there. The seeds are easily disengaged from the pods, and the most suitable instrument for the purpose is the flail.

The dried stems are of little value. They are sometimes given to cattle in place of straw: but it is better that they be employed only as litter, and so made into manure. They are sometimes burned for the potash they contain.

The seeds are spread for a time upon the granary floor, not less than several weeks. They are then bruised in mills of different construction.

The mill used for the bruising of the seeds of this and other plants for oil, is in most parts of Europe a very simple machine: consisting merely of a millstone placed vertically, and moved round by a horse or mule in a circular trough. The seeds being placed before it, it crushes them, and so the oil is expressed. More perfect mills, however, are employed, and perform the work by stamping. In Holland, the Netherlands, and part of Germany, where the culture of the oil-plants is extensively practised, it is common to have an oil-mill attached to the farm. In England the seeds of the oil-plants are always sent to the oil-manufacturer, the preparation of the oil forming a distinct profession.

The refuse consisting of the husks, after the oil is expressed, is rape-cake. This being ground, forms the manure termed rape-dust.

Besides the rape and other species of cabbage, the plants of the *Sinapis* or Mustard genus, and of the *Raphanus* or Radish genus, yield oils from their seeds, and may be cultivated for that purpose.

Of the genus *Sinapis*, either the white or the black species may be sown. The black mustard, *Sinapis nigra*, is the species usually cultivated for the well-known condiment mustard. But the white species, *Sinapis alba*, is rather better suited for the production of oil, it being more productive of pods, and less subject to injury from insects in the early stages of its growth. Either of these species may be sown in March or April, and in July or August the crop will be ripe. They are easily cultivated, but they are apt to spring up again from seeds that may not have vegetated in the first year.

The *Raphanus* or radish is equally suited to yield oils as the mustard. The common radish, *Raphanus sativus*, is well known as a salad. It should be cultivated, as all such plants should, in rows; and. as it spreads over a considerable space, sufficient room should be given to it. It flowers and bears seeds for a long time during the season, but no difficulty exists in knowing the proper period for reaping it. A variety, derived from China, has been supposed to be more productive of seeds than those in common cultivation, and has been accordingly termed *Raphanus sativus oleifer*.

The mustard and the radish have this superiority as oil plants over the rapes commonly cultivated, that they are sown and reaped in the same season. The quality of the oil is nearly equal.

But these plants are never cultivated on the large scale in England. They are, however, supplied in considerable quantities to the oil manufacturers by nurserymen, who dispose of their spare produce in this manner. Even the wild mustard and wild radish, plants which sometimes spring up in vast quantities in our cultivated fields, yield seeds which produce oil; and sometimes the produce of these destructive weeds may in this manner be turned to account.

Almost all cruciferous plants yield more or less of oil. One of these, *Camelina sativa*, cultivated Camelina, is a plant produced in various parts of Germany and Italy for this purpose.

This plant is, like the last-mentioned species, an annual, and is raised with facility. It grows spontaneously over a great part of Europe, and is a frequent weed amongst flax. It grows best on light sandy soils, and in the south of Europe two crops of it can be produced within the year. The oil it produces is said to be fine in quality, retaining a good flavour, and in burning it does not produce any disagreeable odour. In the south of Europe it is sown in April or May, and is sometimes ready in less than three months, so that it is one of the quickest growing of the oleaginous plants. The seeds are sown thin, and the plants hoed if too thick. It is pulled or cut, and laid in a covered place to complete the ripening and drying of the seeds. These being then freed from the stalks by beating, are winnowed, dried, and bruised.

Linum usitatissimum, flax, yields an oil by expression, which is greatly used in the arts. But it is cultivated at the same time for its fibres ; and for obtaining its oil, it is merely suffered to stand until its seeds are matured. The manner of separating the capsules which contain the seeds from the stems, has been described. The seeds are bruised in the same manner as those of the other oleaginous plants. The refuse after expression is termed *oil-cake*, and forms a nutritive food for cattle.

The seeds of the hemp, in like manner, yield oil, which is employed for nearly the same purposes as the oil of flax. The hemp, however, being diœcious, only part of the crop yields oil, namely, the female or seed-bearing plants.

The Poppy is cultivated in various parts of Europe for its oil. The oil of the poppy is sweet, and well suited for domestic uses. It is esteemed to be the next in quality to that of the olive.

Any of the species of *Papaver* will yield oil. But that which is generally cultivated in Europe for this purpose, is one or other of the varieties of *Papaver somniferum*, the sleep-bringing or opium poppy.

The soil for the poppy requires to be well pulverized and manured. In the parts of Flanders where it is cultivated, this point is especially attended to. It frequently succeeds rape in the rotation, manure being applied to both crops. It should be sown early, as in March or April, cultivated in rows, and the plants thinned out to 6 or 8 inches distant. The mode of reaping it in Flanders is peculiar. Sheets are laid along the line of the standing crop, upon which the reapers, gently bending the heads forward, shake out the seeds from the capsules. When no more seeds will fall from the capsules, the row is pulled up and placed in upright sheaves, in order to allow those capsules to ripen which had not at first yielded their seeds. The sheets are then drawn forward to the next row, and so the process is continued throughout the field.

Some plants of the natural family *Compositæ* yield seeds which will produce oils by expression. One of these *Helianthus annuus*, the Sunflower, has been cultivated in some parts of Europe for this purpose. This plant, a native of America, and familiar to us as a garden flower, is easily cultivated. But it does not rank high as an oil-bearing plant, and its seeds are more usefully employed for the feeding of domestic fowls. Another plant of the same family, *Madia sativa*, likewise a native of America, has been recently cultivated in Europe for its oil, and the result of the experiment is said to have been favourable.

Several of the natural family *Umbelliferæ* may be also cultivated for their oils. One of these is Coriander, *Coriandrum sativum*, a plant which is, however, more frequently cultivated for the aromatic flavour of its seeds.

Of the trees whose fruits or seeds yield oils, the most important is the Olive, derived originally, it is believed, from the East, but now cultivated on all the shores of the Mediterranean, and the southern counties of Europe. The oil of the olive is obtained in small quantity from its seeds, but chiefly from the pulpy substance of its fruit.

The Almond is a tree yielding oil of high estimation, but its cultivation is confined to the warmer countries. Proceeding northwards, the olive is succeeded by the walnut, the beech, and the hazel. The oil of these plants is obtained from the seeds, and is sometimes mixed with and sold as the oil of the olive.

The warmer regions of the world abound in plants producing oils; such is *Ricinus communis*, the Castor-oil plant, which is also cultivated in the south of Europe. There, however, it is only an herbaceous plant; but in Africa and the warmer parts of America, where it is largely produced, it is a tree. In the Brazils it affords the principal part of the oil consumed in lamps.

Another of the oleaginous plants of warmer countries is *Arachis hypogæa*, American Earthnut. This plant is remarkable for ripening its seeds under ground. It has been cultivated in the south of Europe; and with some care it has been made to ripen its seeds in the latitude of Paris, and is grown abundantly in the Southern United States of America.

Another of the oleaginous plants is *Sesamum*, Oily Grain, of which there are several species. Oily grain is one of the principal herbaceous oil-plants of Africa and eastern countries. It was an oil-plant of the ancient Jews, as it still is of their descendants, of the Arabs, and of other eastern nations. In Asia, it is the most generally diffused of all the oleaginous plants. It is grown in the south of Europe, but is unfit for cultivation in higher latitudes.

The growing of the oil-plants forms an important part of the agriculture of many countries. In England, the cultivation of these plants is regarded as of minor interest, and is little practised; not because oil is little consumed in England, but because that which is required for domestic purposes and the arts can be derived from other countries by commerce.

V. PLANTS CULTIVATED FOR THEIR DYES.

The plants chiefly cultivated in the north of Europe for their dyes are:—

1. Isatis tinctoria—Woad.
2. Rubia tinctorum—Madder.
3. Reseda Luteola—Weld.

Isatis tinctoria, Woad, is indigenous in various parts of Europe. It is one of those plants which yield the deep blue colouring matter so greatly valued in the arts, Indigo. It was in extensive use in Europe previous to the introduction of the indigo of commerce, which is derived from the green parts of certain species of *Indigofera*, the production of warmer countries.

Woad is a perfectly hardy plant, and in this climate is a biennial. Its seeds may be sown early in spring, in which case a certain produce of leaves may be obtained in the same season; or it may be sown in summer or autumn, when the return is obtained in the second year.

The plant requires a deep rich soil, perfect preparation of the ground, and a careful tillage during the period of growth. It is best cultivated in rows at such distances from one another as to admit of the operation of the horse and hand hoe. It is usually grown on a flat surface, although it may be cultivated in raised drills in the same manner as turnips. When the leaves are of their full size, and before they have begun to change to their paler colour, they are picked off by the hand; and in this manner successive crops are obtained during the season; and when the plants have shot forth their flowering stems in July or August, the land is ploughed and prepared for another kind of crop.

The leaves, when collected, are washed, and, being dried, are carried to a mill similar to that used for bruising the seeds of oil plants. The paste obtained is placed in heaps, and fermented, and the heaps are then broken down and formed into balls, which are the subject of commerce: or else the paste is first formed into balls, which are dried in proper apartments; and to fit these balls for the dyeing process, they are reduced to powder in the same mill which had been employed to form the paste. The ground material is then spread 3 feet deep on a floor, moistened with water and slowly fermented. Being then gradually cooled, it is ready for being stored in casks, or otherwise preserved until required for use.

The colouring substance may also be obtained, like that of the indigo plant, separately from the leaves. This is done by fermenting the leaves in water, and extracting the colouring substance from the green part of the plant. The process is described in a work drawn up by the French Government in 1811, at which time the cultivation of woad was a favourite object with Napoleon, in his endeavours to find substitutes for the colonial produce of other countries. This method of preparation, however, does not seem to have been extended; and less artificial processes prevail where the woad-culture is practised.

The culture of the woad, and the preparing of the leaves, require a minute care scarce compatible with the regular business of the farm, as practised in this country. But the yet greater objection to its more extended culture is the uncertainty of the returns, arising from the competition of the indigo of commerce, which can be obtained in great abundance from the intertropical countries of Asia and America.

The next of the common dye plants of Europe is Madder, *Rubia tinctorum*. This plant has an annual stem, but it is from the root that the dye is produced. Like others of the family to which it belongs, it tinges with red the milk, the urine, and the bones of the animals that feed upon it.

The root is composed of long succulent fibres, which strike deep into the ground. The plant is best raised from sets, and should be cultivated in rows with a good distance between. The method of the drill turnip culture seems entirely suited to the habits of this plant; and doubtless in this manner it could be successfully raised. The roots are taken up before winter in the third year, at which time, if the soil has been suitable, they will be frequently found extending from 3 to 4 feet deep in the earth. The proper kind of soil for this plant is a deep sand.

The roots, when taken from the ground, are dried by a moderate heat, and then pounded by stampers. The first beating separates an inferior kind of madder mixed with impurities; the second beating a medium sort; the third is the interior and brighter part of the roots, called in this country *crop*-madder. The dye thus produced is a peculiar red, and is a substitute for cochineal.

Holland was long the country from which we derived our supplies of madder, and the plant is still much cultivated by the Dutch and Flemings. It can be readily raised in England, for it is not a plant of difficult culture; but experience has shown, that it can be produced more cheaply in countries where the climate is more favourable, and the cost of production less.

Weld, or Dyer's Weed. *Reseda Luteola*. is another of this class of plants. It is of the Resedaceæ. or mignonette family. It is a native, and generally a biennial. It is found upon earth brought from a great depth, as the rubbish of coal-mines.

The weld affords a fine yellow dye for cotton, wool, silk, and other substances. The weld and the bark of the *Quercus tinctoria* yield the principal yellow dyes employed in the arts: but the latter is now in the most general estimation in this country.

The weld is the most easily cultivated of all the dye plants, growing on a variety of soils, without requiring one of great fertility. It may be cultivated in the same manner as the clovers and common grasses, that is, it may be sown with any crop of corn, and reaped the following year. In this manner it is sometimes cultivated, being mixed with the clovers and grasses, and plucked up from amongst them when it is in flower.

But the surer method of cultivating the weld is by itself, in which case it may be sown, in the month of May or later, broadcast or in rows. The surface of the ground should be well smoothed, and the seeds, which are very small, lightly covered. The plants are to be carefully cleaned during the period of their growth, and in the month of July in the second year they will be in full flower, and then they are to be pulled up, without waiting for the ripening of the seeds.

The plants are pulled up by the roots, and set upright, generally four together, to dry. When they are sufficiently dry, which will be in the course of a week or more, they are bound into larger bundles, in which state they are ready for sale; or they may be stacked, and preserved for years without suffering injury. The culture of the weld, therefore, differs from the other dye plants in this, that no part of the preparation of the dyer falls upon the grower. The dye when extracted from the stalk, must be soon used, otherwise it will ferment and become useless.

The produce varies greatly with the seasons, being from 12 to 40 cwt. of stems or more to the acre. It sometimes yields a good profit, but the demand for it is very uncertain. It is exceedingly subject to a species of blight. Coupling this with the unequal demand, little advantage seems likely to be derived from the more extended culture of it in this island.

The woad, the madder, and the weld, are the plants usually cultivated on the large scale for their dyes in the north of Europe. But innumerable other plants yield those beautiful substances, and are partially cultivated:

1. *Crocus sativus*, Saffron Crocus, an autumnal species of a genus known to us as yielding amongst the earliest of our vernal flowers. The plant is cultivated from bulbs. The dye produced is saffron, and it is derived from the stigma and style of the plant. The colour of the crocus, however, is very fugitive, being obliterated by the action of the solar rays.

2. *Carthamus tinctorius*, Bastard saffron or safflower. It is the flowers of this plant which are used for dyeing. The dye produced is of two kinds, a yellow and red. The yellow is separated by maceration in running water. The remaining dye is a delicate red more beautiful even than cochineal, but it is little permanent. When ground with pure talc, it forms the rouge termed by the French *rouge végétale*. The seeds yield also an oil, which is used in medicine and painting. The plant is cultivated in various parts of Europe, and extensively in Egypt and the Levant, whence great quantities are imported into England for painting and dyeing.

3. *Nerium tinctorium*, Dyer's Oleander, one of a genus of

beautiful evergreens, yields indigo, and it is believed might be cultivated for that purpose.

4. *Galium verum*, Lady's bedstraw, a familiar plant of the natural family *Rubiaceæ*, and yielding, like the madder, a red dye.

5. *Rhamnus infectoria*, Yellow-berried buckthorn, the fruit of which produces a yellow dye, is cultivated in France under the name of *Graine d'Avignon*. The dye is extremely fugitive.

7. *Croton tinctorium*, Officinal croton, yielding a beautiful blue, which is employed to dye silks and wools. This substance is known to us under the name of Turnsole.

A vast number of other plants could be enumerated as yielding dyes, and capable of being cultivated for that purpose. The colours they yield are more or less valued for their permanence and beauty.

VI. PLANTS CULTIVATED FOR THEIR SUGAR.

Of the plants which are either cultivated, or which admit of cultivation, in Europe, for their sugar, the following may be enumerated:—

1. Beta cicla et vulgaris—White and Common Beet.
2. Brassica Rapa, Solanum tuberosum, Pastinaca sativa, and other plants producing tuber and mucilaginous roots.
3. Vitis vinifera, and other species of Grape.
4. Betula alba—The Birch.
5. Acer saccharinum—The Sugar-Maple.
6. Saccharum officinarum—The Sugar-Cane.

The Beet is now cultivated largely in France for its sugar. The sugar produced can be crystallized, and is then little inferior to that derived from the sugar-cane; but it cannot yet enter into competition with the latter with respect to cheapness of production. The manufacture in France owed its origin to the rude plans of Napoleon, to render his empire independent of the sugar of commerce, and is now only maintained by a system of fiscal regulations, which exclude, or admit only on unfavourable conditions, the produce of the sugar-plant of the tropics.

Although, under the artificial system by which it is supported in France, the manufacture of the sugar of beet cannot be regarded with favour, yet it is of great interest and curiosity, as evincing the large quantity of sugar which exists in certain vegetables, or the facility with which their constituent parts may be converted into this nutritive and grateful substance.

Besides the beet, the roots of many common plants produce sugar; such are, the turnip, and others of the cabbage genus; the potato, the parsnep, and other plants which have tubers or large mucilaginous roots. None of these, however, has been cultivated on the large scale for sugar, though many of them have been subjected to experiments, which evince the possibility of deriving sugar from them in considerable quantity.

The Vine, *Vitis vinifera*, and other species of Grape, yield sugar; but they are never cultivated for this purpose; for, while they are inferior to other plants for the production of sugar, they are superior to any for the special purpose for which they are cultivated—the production of wine.

The Birch, *Betula alba*, when its stem is perforated, yields a large quantity of juice, from which sugar may be obtained by boiling; and the inhabitants of countries where the birch abounds, supply themselves, in this manner, with a species of domestic sugar.

The Sugar-maple, *Acer saccharinum*, is one of the innumerable marvels of the American forest, extending over a vast tract of country, from Lake St John, in Canada, to the upper parts of Pennsylvania. The juice is extracted in the early part of the year, while the ground is yet covered with snow, by boring holes with an auger in the trunk. The juice, which continues to flow for five or six weeks, is conveyed to a trough at the foot of each tree, and collected every day, and poured into casks, from which it is drawn to fill the boilers, which are upon the spot. It is then evaporated by means of a brisk fire, until the liquid is reduced to a syrup, when it is left to cool, and it is then strained through woollen cloth, to separate the impurities. It is boiled a second time, until it is of a proper consistency to be poured into moulds. The sugar obtained in this manner is equally grateful to the taste as the brown sugar derived from the sugar-cane; and it is equally suited for culinary uses; and when it is refined, it equals the finest sugars consumed in Europe. The sugar of the maple supplies a large internal consumption in Canada and the Northern United States of America; but the plant has not been introduced for this purpose into the culture of Europe. Other species of *Acerineæ* yield sugar, but none of them in quantity equal to the sugar-maple.

But the plant which yields the largest supplies of this substance is the Sugar-cane. This plant is of the natural family Gramineæ, and it is of all the family that whose juices are the richest in saccharine matter.

The sugar-cane, however, cannot stand the cold of high latitudes. The zone of its cultivation extends to about 35°, or thence to 40°, on either side of the Equator; and it is only produced in the temperature of the colder countries of Europe by artificial means. It is partially cultivated in the islands of the Greek Archipelago, and its cultivation yet lingers in some of the provinces of Spain; but it is scarcely now regarded as one of the cultivated plants of Europe. Its produce, however, can be obtained, in unlimited quantity, from the intertropical regions of either hemisphere.

VIII. PLANTS CULTIVATED FOR THEIR NARCOTIC, BITTER AND TANNIN PRINCIPLE.

1. NARCOTIC PRINCIPLE.

Of the plants which afford the narcotic principle, the most important are the Tobacco and the Poppy.

1. The Tobacco, *Nicotiana*, is of the Nightshade tribe. It

was before seen, that the wholesome and esteemed potato is of this formidable family of plants, possessing in its leaves and root, until expelled by heat, the same dangerous properties.

Of the tobacco there are many species. Those most generally cultivated are—

1. Nicotiana tabacum—Virginian Tobacco.
2. Nicotiana rustica—Common Green Tobacco.

Some of the many species of tobacco are natives of Asia, but the most important of them have been derived from the New World; and none of them appears to have been used for luxury or commerce till obtained from that continent.

The discovery of this plant is supposed to have been made by Fernando Cortes, in Yucatan, in the Gulf of Mexico, where he found it used universally, and held in a species of veneration, by the simple natives. He made himself acquainted with the uses and supposed virtues of the plant, and the manner of cultivating it, and sent plants to Spain, as part of the spoils and treasures of his new found World.

But it was the Portuguese who were mainly instrumental in diffusing the tobacco plant over Europe and the East. The history of its introduction into different countries is very remarkable, but need not here be detailed. It is known, that the use of this plant, seemingly nauseous, has, in spite of all opposition, taken root as it were in every country, and become apparently essential to the comfort of the inhabitants.

The tobacco-plant grows in all the temperate zones to a high latitude. It is cultivated extensively in Germany, France, and the Low Countries, in Sweden, Russia, and other parts of Europe. It required a long series of intemperate laws to arrest its progress in England, and its culture there is now directly prohibited, on account of the great revenue derived from the foreign commodity. It is not necessary here to canvass the policy of these laws. They can be justified only on the plea of necessity, which compels us to trust to the importation of foreign tobacco for a large part of the revenue of the country.

The tobacco-plant requires a rich light soil, and its cultivation is attended with a considerable labour of detail.

The seeds, which are very minute, are generally sown in a sheltered place, covered during the night to defend them from frosts, and, in the end of May, or beginning of June, transplanted to the fields, and set in rows at a sufficient distance from one another. The culture they there undergo is hoeing, to keep them free from weeds, removing insects and injured leaves, and picking off the summits and buds, to prevent the flowering of the plant, and to direct the nourishment to the leaves.

When the leaves are ready, the stems are cut over, the plants hung up and dried, and then put into heaps, and made to undergo a degree of fermentation. They are again hung up, the leaves being separated from the stems, and made to undergo a second fermentation, under a certain degree of pressure. The leaves are again dried, and tied together in bundles. They are then packed, and compressed in casks, for sale or exportation, which completes the task of the grower.

The average produce differs very greatly under different conditions of climate and culture. Mr Brodigan, who cultivated the plant extensively in Ireland, states the produce in the county of Wexford at 1200 lb. per acre.

The whole details of the operation of culture will be found in various works. The most recent, with respect to its cultivation in this country, is by Mr Brodigan, whose treatise is very complete, and founded on experience. A full summary of the practice, as pursued in different countries, is given in the *Nouveau Cours complet d'Agriculture*, by M. Bosc.

The tobacco-plant is found to grow in all the temperate regions, but that produced within the tropics possesses the finest flavour. The quantity produced and consumed of this plant is immense.

It may be asked, what it is which renders this seemingly unpalatable herb so grateful to the palate and the system in every climate, and in every form in which it can be used. Even in the most nauseous way in which it can be consumed, that of chewing, the use of it becomes a passion, and few that have used it in any form ever willingly abandon it.

It is evidently a soothing narcotic, of which the universal taste of mankind approves; and it is hard to believe that a taste so universal should be given for a substance that is in itself noxious. It may be abused, indeed, like many gifts of Nature; but all the presumption is, that, in moderate use, it is harmless as well as grateful.

2. The Poppy is of the genus *Papaver*, of which there are various species. That which is chiefly cultivated for its narcotic principle is

Papaver somniferum—The Opium Poppy.

The flowers of this species are sometimes white, when the seeds are also white; and sometimes the flowers are white and purple, when the seeds are of a darkish blue colour. The first is the variety *album*, the latter the variety *nigrum*, of De Candolle. The darkish-coloured seeds are obtained from Germany, under the name of maw-seeds. This plant grows, in favourable situations, to the height of five or six feet. The petals of the flowers are of short duration, being succeeded by large round heads, somewhat flattened. It is from these heads or capsules, that the opium is derived.

Being an annual plant, the poppy when sown in spring, matures its seeds early in autumn. It is of easy culture, and can be produced in the north of Europe, and the opium extracted from it.

In England, the seeds may be sown from the middle of March to the middle of April. The best method of cultivating the plant is in rows; and on the poppies attaining a few inches in height, hoeing them out to a distance from one another of six or eight inches.

When the heads are fully formed, but are yet green, the opium may be extracted. This process is simple, and may be taught to children in an hour.

Two or more vertical incisions are made in the capsule with a sharp knife or other instrument, about an inch in length, and not so deep as to penetrate through the capsule. As soon as the incisions are made, a milky juice will flow out, which, being glutinous, will adhere to the capsule. This may be collected by a small hair-brush, such as is used by painters, and squeezed into a little vessel, carried by the person who collects the juice. The incisions are repeated at intervals of a few days all round the capsule, and the same process of collecting the exuded juice is repeated.

The juice thus collected is opium. In a day or two it is of the consistence to be worked up into a mass. The narcotic matter of the plant may be also collected by boiling; but it is only the exuded juice that forms pure opium.

In the opium-countries of the East, the incisions are made at sunset, by several-pointed knives or lancets. In the following day, the juice is collected, scraped off with a small iron scoop, and deposited in earthen pots, where it is worked by the hand until it becomes consistent. It is then formed into globular cakes, and laid in little earthen basins, to be further dried. After the opium is extracted from the capsule, the plant is allowed to stand and ripen its seeds.

The seeds of the poppy, having nothing of the narcotic principle, are eaten by the nations of the East as a nourishing and grateful food; and they yield by expression an oil, which is regarded as inferior only to that of the olive.

It is the expense of labour, and the contingency to which the plant is subject from rains, that form the principal objection to the cultivation of the poppy in this country for its opium. The latter objection, indeed, is greater than the first. The processes of labour, though minute, are simple, and can be performed by children. The trials that have been made on the culture of the opium plant in this country, notwithstanding the partial success of some of them, lead to the conclusion that opium may be better obtained from countries with a warmer and less humid climate than that of England.

2. BITTER PRINCIPLE.

1. The most important of the plants cultivated with us for their bitter principle, is the Hop.

The Hop, *Humulus Lupulus*, has been cultivated in Europe during an unknown period, for its flowers, which are used for giving a bitter flavour to beer, as well as for preserving it. Its roots are perennial, and its stem ascends trees and other supports. It is a diœcious plant, that is, the male and female flowers are on different individuals. The male plants are technically called wild hops, and are rejected as of no value. The hop is a native of this country, and most parts of Europe. It flowers in England in June or July.

The hop is raised from slips taken from the stem, or from sets taken from the root. These are planted either in autumn or in spring; but the latter is the usual time. The plant is in its full bearing in its third year; and a plantation generally lasts from 10 to 15 years, when it must be renewed, the old plants being grubbed up, and fresh sets planted.

The slips or sets are obtained from the pruning of the old plantations, or from the roots. Each slip should contain two joints or buds. The slips are sometimes planted in a garden for a season, before being set in a plantation.

The manner of forming the hop plantation is this:—The ground is deeply ploughed, and well prepared. The places where the sets are to be planted are marked out, which may be done by a plough drawing parallel furrows, at the distance of eight feet from one another, and then by crossing these by similar furrows, at equal distances. The points where these furrows intersect, are the places where the sets are to be planted.

At each of these points of intersection, a hole is dug, and some manure put in it. A little hillock is made, and five, six, or seven sets dibbled in, forming a circle round the top of each hillock, at the distance of five or six inches from one another.

They are set to incline inwards, and one generally is placed in the centre.

In the first year the plants are tilled and hoed in the intervals, and the earth is drawn by the hoe around the roots of the plants, which is termed earthing. The principal earthing is in the first spring of the growth of the plant, but it is repeated annually afterwards in spring.

The process of tilling, hoeing, and earthing up, is an annual operation, and manure is applied generally once in three years. It is either laid on the hills of hops as they are termed, or in the rows. An esteemed manure for this plant is woollen rags.

The plants yield nothing during the first year. In the second year they yield their first crop of flowers. In preparation for this the poles are set. This operation is performed generally in the end of April, when the plants are 2 or 3 inches high.

The poles consist of straight shoots of ash, oak, willow, or other tree, from 6 to 9 inches in circumference at the base, and tapering to the size of a small cane. Two, but more generally three or even more poles, are placed on each hill. They are fixed in the ground by making deep holes with an iron-crow, their tops inclining somewhat outwards.

The next operation consists in tying to the poles the shoots which it is wished to preserve. This is a work of skill, and one upon the right performance of which part of the success of the crop depends. The shoots not to be preserved are cut away. The tying up of the shoots is by means of withered rushes, so loosely tied as to allow the free growth of the shoots. When the warm weather arrives, the shoots grow with extraordinary rapidity, twining round the pole.

The season of picking the hop is usually the beginning of September. The period is known by the hop acquiring a strong scent. The manner of performing the work of picking is this:—

Frames of wood are raised in the most convenient part of the plantation. These frames consist of four boards nailed to four upright posts, the whole frame being about 8 feet long, 3 feet wide, and 3 feet high. Six, seven, or eight pickers, generally women or boys, are placed at the same frame, three or four being on each side. The plants being cut through at the root, the poles are lifted up and laid on the frame with the hops upon them.

The pickers then carefully pick off the flowers of hops, which they drop upon a large cloth which is hung upon the frame with tenter-hooks. When this cloth is full, the hops are emptied into a large sack and carried home.

The hops are then kiln-dried, which is done by placing them on a hair-cloth, 10 or 12 inches deep. The heat is gradually increased to the proper height, and continued steady eight or ten hours. The hops are then taken from the kiln, and laid in a large room or loft until they become cool.

The next process is packing the hops into bags or pockets. In the floor of the room is a round hole, equal to the size of the mouth of the bag. The mouth of the bag is then fixed firmly to a strong hoop, which is made to rest on the edge of the hole. The bag is then let through the hole suspended by the hoop, and the packer goes into it. Another person puts the hops into the bag in small quantities at a time, and the packer tramples them firmly down. When the bag is full it is drawn up and the end sewed. The hops are now ready for sale.

In the mean time, the poles in the plantations have been stript of the stems attached to them, and piled in stacks to await the following year.

The produce of the hop is more variable than that of any other crop. It is frequently nearly a failure. It is sometimes as low as 1 or 2 cwt. to the acre, and sometimes as high as 20; the average produce may be stated at about 10 cwt. or less.

The stalks, like those of other plants of the natural family *Urticeæ*, yield fibres, which may be made into cloth. They are treated like the hemp; but the woody part is with more difficulty separated, and requires a longer maceration.

The hop is liable to diseases and the attacks of insects beyond any other of our cultivated plants. At the first stage of its growth, it is attacked by an insect of the flea kind, similar to that which attacks the young turnip. At a more advanced stage, it is attacked by numerous lice as they are called, the young of a little green fly, which frequently greatly injure or totally destroy the plant. Other insects also prey upon it, and plants of the mushroom family grow upon it, forming mildew or blights.

From this general account of the manner of cultivating the hop, it will be seen that the cultivation of it is attended with considerable difficulty, all the processes of tilling and dressing the plant, until its final preparation, requiring minute attention and much labour. It is also a very expensive species of cultivation, arising from the large outlay required for the poles. From this circumstance, from the great uncertainty of the returns, and from the whole preparation of the produce being subject to the superintendence of the excise, the culture of the hop in this country does not extend, and is not likely to do so.

The hop is used for preserving and giving a bitter taste to malt liquor, to which purpose it is exceedingly well suited. Many bitters, however, may be used in place of the hop, and these, on account of the enhanced price of the hop, are employed clandestinely in this country to a great extent. Some are injurious, as the *Cocculus indicus*, which has not only a bitter but a narcotic principle, and is in truth a poison; and others are innocent.

2. Common Broom, *Cytisus coparius*. The young shoots of this plant yield a bitter; and the method adopted is to mix a portion of them with a quantity of hops.

3. Mugwort, *Artemisia vulgaris*. This plant, like some others of the natural family to which it belongs, is tonic; and as it also yields a bitter, it may be used as a substitute for hops.

4. Ground-Ivy, *Glechoma hederacea*. This plant was formerly used for giving a flavour to ale. It belongs to the Mint tribe of plants, which are generally tonic and cordial.

5. Marsh-Trefoil, or Buckbean, *Menyanthes trifoliata*, is a

common plant, perfectly wholesome, and, as a bitter, is believed to be superior to the hop. It is the roots which are used for this purpose.

6. Quassia is also a bitter, used clandestinely in the brewing of beer. It is derived from the bark of a tree found in the woods of Surinam. It is a very intense bitter, and is used in medicine as well as in brewing.

7. But the most important of the plants yielding bitters are those of the natural family *Gentianæ*. The Gentian family of plants seems intended by nature to supply this principle. They are herbaceous, and extend over almost every part of the world, from the highest mountains of Europe to the arid sands of India and America. The principle of bitterness resides in their roots. They are all of them tonic and stomachic. They are the most generally extended febrifuges known, and are, consequently, valuable medicines for the most fatal class of disorders incident to the human race. *Gentiana lutea*, Yellow gentian, is a native of the Alps of Europe, and is chiefly employed in France and England: *Gentiana rubra* is the species principally used in Germany; and *Gentiana purpurea* in Norway and Sweden. Their properties are the same. The yellow gentian, when formerly employed in the Old English ales, was termed Bitterwort.

3. TANNIN PRINCIPLE.

The plants the most commonly employed for the purpose of yielding tannin are the Oak, the Willow, the Chestnut, and the Larch; and it is chiefly from the bark that the tannin principle is derived.

Of these forest-trees the oak is the most esteemed for its tannin, although it appears that certain species of willow are not inferior to it in the quantity and quality of the tannin which they produce.

The oak produces tannin from its galls, but it is chiefly produced from its bark, and this in the largest quantity when the buds begin to open in spring. It yields the smallest quantity in winter, after the autumnal descent of the sap. It is for this reason that the oak is too frequently cut down at a time which, though favourable for the production of tannin, is not so for the ultimate durability of the timber.

Sir Humphrey Davy made various experiments on the quantity of tannin yielded by the bark of different species of trees. He found that the greatest quantity was produced by the Leicester willow of large size. From 480 lb. of bark,

The Large-sized Willow yielded	33 lb.
The Common Willow,	11
Coppice Oak,	32
Middle-sized Oak cut in spring,	29
The Spanish Chestnut cut in autumn,	21
The Ash,	16
The Black Thorn,	16
The Larch, when cut in autumn,	8

Of these trees, the larch, it will appear, yields the smallest quantity, weight for weight; but then the larch produces a considerable quantity of bark, for which reason it is common to strip the trees of their bark when felled. Other coniferous trees are rich in the tannin principle, as the Hemlock-spruce of America.

The Myrtle family of plants are some of them very productive of tannin. The loftiest timber trees of New Holland and Van Diemen's Land are of this family, and tannin in considerable quantity has been recently obtained from the Australian woods. From the same vast country Acacia has been imported on account of its tannin; for it is to be observed that several of this genus yield tannin in great quantity. In some species of Acacia of the western parts of America, the extract yielded consists chiefly of tannin.

The Sumach is also a genus of plants which yields a considerable portion of tannin: one of the species, *Rhus Coriaria*, is used in Turkey for tanning the leather of that country; another of the species, *Rhus Cotinus*, is said to be cultivated in the Apennines for the same purpose.

Tannin is found in the roots and leaves of many other trees and shrubs. Some common plants of the Rose family yield it largely, and indeed it is a very commonly diffused vegetable principle.

VIII. PLANTS CULTIVATED FOR THEIR RESINS.

The most important of the plants yielding resinous substances are the *Coniferæ* or Fir-tribe.

The trees which form the family of Coniferæ are of high importance, both on account of the timber which they produce, and their numerous secretions. It is with relation to the last of these productions that they are to be here adverted to. These secretions are termed *resins*, and they are of very great importance in the arts.

From the Wild pine, *Pinus sylvestris*, frequently called the Scotch fir, is obtained common tar. The manufacture is carried on in those vast countries of pine which form so great a part of northern Europe.

The manufacture is simple. A conical hole, usually in the side of a bank, being made, roots and fillets of pine, are let into the cavity, and the whole is covered with turf, which is beat firmly down above the wood. The wood being kindled, a slow combustion takes place. A cast-iron pan at the bottom of the cavity receives the fluid, and has a spout which projects through the bank, and carries the tar into barrels. As quickly as the barrels are filled, they are closed with bungs, when the material is ready for exportation. This manner of preparing tar has been derived from the earliest ages. By the further application of heat, the tar is converted into pitch.

These two substances, tar and pitch, are of extensive use in the arts. The employment of them in the preservation of the ropes and cordage of shipping is everywhere known. The importation of tar into this country from the north of Europe and from America, is very great. The tar of America, however, is not derived from the consumption of the wild pine, which does not exist in the New World, but from other species, and chiefly from the swamp pine, *Pinus australis*.

The Norway spruce, *Abies communis*, is applied to the same purposes as the wild pine.

Common turpentine is likewise an extensive production of certain coniferous trees. It is not obtained by heat, but by the natural exudation of the juices of the plant, through incisions of the trunk.

Turpentine is resolvable into two parts. The one is rosin, a substance extensively used in the arts. By distillation oil is obtained, what remains being rosin. The oil of turpentine has frequently the name given to it of spirits of turpentine; but, though a very powerful substance, it has no resemblance to alcohol.

Turpentine is obtained from others of the pine family besides the wild pine; and, according to the species from which it is derived, the turpentine possesses peculiarities which fit it for different purposes in the arts.

Turpentine is extensively produced in the United States of America. A sort of cavity is formed at the root of the tree, capable of holding about a pint and a half of juice: and an incision being made in the bark, the turpentine flows into the cavity, which is emptied five or six times in the season.

Venetian turpentine is obtained from *Larix europea*, the Common larch. The turpentine of the larch is generally obtained from the Alps of the Tyrol: and the shipping-port being Venice, it thence derives its name of Venetian turpentine.

The Bordeaux turpentine is derived from the Cluster pine, *Pinus pinaster*.

The Strasburg turpentine is derived from the Silver fir, *Abies picea*. This majestic tree is extremely prolific of resinous matter.

The Cyprus turpentine is obtained from *Pistacia Terebinthus*, the turpentine tree of the south of Europe. The islands of Cyprus and Chio are productive of this species of turpentine: which, however, is scarce, costly, and adulterated in commerce with the less valuable kinds.

The obtaining of the exuded juice, in this manner, does not, as in the case of tar, infer the destruction of the tree; but when turpentine is procured by incision, the tree is weakened, and hence, from the small extent of coniferous forests in this country, and from the time required for the collection of the exuded juice, it is found better to derive the turpentine employed in the arts from other countries.

Other resinous substances are, in like manner, obtained from various Coniferæ; as the Canadian balsam, from *Abies Balsamea;* the Carpathian balsam, from *Pinus Pinea;* the Hungarian balsam, from *Pinus Pumilio.* &c.

IX. PLANTS CULTIVATED FOR THEIR FRUITS.

Of the plants cultivated for their fruits, the following classes may be enumerated:—

1. Vitis vinifera—The Vine.
2. Pyrus Malus—The Apple, and others of the Apple tribe; as the Pear, the Medlar, and the Quince.
3. Amygdalus persica—The peach and others of the Almond tribe, as the Plum, the Apricot, and the Cherry.
4. Fragaria vesca—The Strawberry and other fruit-bearing plants of the Rose family; as the Raspberry, and others.
5. Ribes grossularia—The Gooseberry, and others of the Currant tribe.
6. Cucurbita Pepo—The Pumpkin, and others of the Gourd tribe.
7. Corylus Avellana—The Hazel, and others of the Oak tribe; as the Oak, the Chestnut, and the Beech:—Juglans regia, the Walnut; and other trees and shrubs bearing nuts and berries.

The first in the order of these fruits is the Vine, the true region of which, in Europe, is to the southward of the 50 of latitude. Within this zone, the vine is the most important of all the plants cultivated for their fruits, employing a large part of the industry of the inhabitants, and yielding the liquor which is in most general use. Beyond the natural limits of the vine, to the north, it is the plant of the garden, and is usually raised by artificial heat.

The next class of plants, the *Pomaceæ*, or apple tribe, comprehends the most important of the fruit-bearing trees of northern Europe. They are hardy and of easy culture. They yield fruits employed in many ways as food, and their juice supplies a fermented liquor. They have been cultivated and improved with great care in England, which now numbers a vast variety of this class of fruits.

The next class comprehends many of our most esteemed fruits—the Apricot, the Peach, the Nectarine, the Plum, and the Cherry. Though highly valued for their juicy fruits, a dangerous principle, hydrocyanic or prussic acid, resides in their leaves and kernels, which renders them less safe as food than the fruits of the apple tribe.

The Strawberry, of different species, is a native of the Old World and the New, yielding an esteemed and wholesome fruit. Of this tribe are the Raspberry, and others, largely produced in the south of Europe.

The Gooseberry, and other plants of the Currant tribe, yield fruits which are esteemed in the colder, though not in the warmer, parts of Europe. The plants of the Currant tribe are hardy, and of easy propagation.

The larger kinds of the Gourd tribe are cultivated in the fields. They yield a great produce where circumstances are favourable to their growth: but they are suited to the warmer, and not to the colder parts of Europe. Of this tribe are the Melon and the Cucumber, which are plants entirely of the garden.

The last class of plants enumerated consists of those of which the seeds are eaten. Of this class is the Hazel, which is sometimes cultivated on the larger scale; so likewise are the Chestnut and the Walnut; but the chestnut and the walnut belong to the warmer parts of Europe.

X. PLANTS CULTIVATED FOR FERMENTED AND DISTILLED LIQUORS.

The juices and soluble matter of many plants are susceptible of the vinous fermentation. During this process, a principle is formed, alcohol, which may be obtained separately by distillation. The liquors, in their first state, are fermented liquors; such are wine, cider, beer. The substances obtained from these, by the process of distillation, are distilled liquors. Many plants are cultivated for yielding these substances. The most important of them are the following:—

1. The Vine.
2. The Apple, and other Pomaceæ.
3. The Peach, and other Amygdalaceæ.
4. The Strawberry, and other Rosaceæ.
5. The Gooseberry, and other Grossulaceæ.
6. The Cereal Grasses.
7. The Parsnep, the Carrot, the Beet, and other plants producing mucilaginous roots and tubers.

At the head of this class of plants stands the Vine, the fruit of which has, in every age, been employed for the production of fermented liquor. The vine may be cultivated within the tropics, but that is not the natural region of the cultivated vine, which, in the northern hemisphere, may be said to extend from about the 25th to near the 50th degree of latitude.

Although of vast importance to the agriculturists of the wine-growing countries of Europe, the fermented produce of the grape can, in this and other countries similarly situated, be regarded only as the subject of commerce, since no supposable contingency can arise in the colder countries to render it expedient to attempt the cultivation of this plant for its wine.

It is otherwise with the next class of enumerated fruits, the *Pomaceæ*. These are hardy plants of easy culture, suited to the climate, and capable of producing, in unlimited quantity, a nutritive and grateful liquor. The wine of the apple is termed cider, that of the pear perry. The preparation of cider is a simple process. The apples being gathered, which must be done when they are thoroughly ripe, are piled into a heap about a foot high. This heap may be defended from the rain, but the air should be allowed access to it. After the fruit has lain for a time to mellow, all decayed apples being in the mean time removed, it is carried to the bruising mill.

This, in most of the cider countries of Europe, is a very simple machine, consisting merely of a common millstone, placed vertically, and made to be moved round in a circular stone-trough by a shaft extending beyond the trough, to which a horse is attached. The vertical millstone should be made of any hard stone, but not of limestone, because the malic acid of the fruit acts upon the calcareous matter: neither should any lead be employed.

The vertical millstone may be 4 feet in diameter, and 10 or 12 inches thick; the groove in which it is to run in the trough, may be 9 or 10 inches deep, of sufficient breadth at the bottom to allow the stone to move freely, and 6 or 8 inches wider at the top than at the bottom. The apples are strewed in the trough, and crushed by the stone as it revolves.

The pulpy mass being removed, is allowed to remain about twenty-four hours in a heap, after which it is carried to the cider press. This is usually formed on the principle of a common screw-press. Boards placed horizontally compress the pulpy matter, and the screw which presses them together is moved by levers. The pulp is placed usually in hair-bags, one above the other, between the horizontal boards. These are slightly compressed at first, and then more strongly, until the juice is fully expressed. The juice is received in proper vessels, and after being pressed through a hair-sieve to retain the grosser parts, it is conveyed to a cask, where it is suffered to ferment.

The fermentative process proceeds, and when it is completed the liquor is withdrawn, or racked as it is termed, the impurities being left behind. Should the vinous juice show a disposition to ferment a second time, it must be again racked, and so on till the tendency to fermentation be removed. The cider now formed is put into the casks in which it is to remain. It is kept in these until it is fit for being put into bottles, when, if well made, it will be found to be a clear rich liquor, and will remain in these bottles, without loss of its properties, for twenty or thirty years. Cider, then, it appears, is a true wine without any addition to the fermented juice of the fruit.

The manufacture of perry is entirely the same as that of cider, the pear being substituted for the apple.

The preparation of these liquors is attended with no peculiar difficulty, and might be extended to every part of the country. It is not the finer garden apples that are required for the cider manufacture. They are rather of the less improved and harsher kinds, approaching somewhat to the wild apple. Nay, the wild apple itself, one of the most easily cultivated of trees, will yield good cider alone, but unexceptionable cider if mixed with a proportion of the cultivated apple. In truth, although most writers would have us believe that there is something of much moment in the choice of a particular kind of apple, it is well established that the principal success of the cider production, in the different countries of the north of Europe, depends on the manner of performing the operation rather than upon the kind of fruit.

The Peach, the Plum, and others of the Almond tribe, also produce liquors, but these are generally distilled liquors. The brandy of the peach is extensively consumed in some parts of the United States of America.

The Strawberry, and other fruit-bearing *Rosaceæ*, and the Gooseberry, and other fruits of the Currant tribe, may also be converted by the vinous fermentation into wine.

The general character of these fruits is, that they are deficient in those saccharine properties which suit the grape and the apple tribe to the production of wine. They undergo the acetous in place of the vinous fermentation, and all of them accordingly require an addition of sugar to cause them to become wine. The addition of sugar produces readily the fermentation required; but it is common also to add a distilled liquor to give strength and flavour to them.

Those domestic wines are an article of household economy, and although they want the flavour of the wine of the grape, they are not unpalatable. Some of them undergo the vinous fermentation by the sole addition of saccharine matter, and do not require the addition of alcohol; and these are true wines.

Others again are not palatable, and will not keep without this addition: and these are not true wines, but a mixture of distilled and fermented liquors.

The next class of plants producing fermented liquors is the cereal grasses. In these, the soluble matter being obtained by infusion, is fermented, and forms beer. This class of liquors includes ale, porter, and the like, which are merely varieties of beer, their different qualities being produced by variations in the manner of performing the fermentative process, and by differences in the substances added to give strength and flavour to the liquor. The grains from which these liquors may be derived are chiefly wheat, rye, barley, oats, maize, millet, rice. In this country, the grain most commonly employed, and found best suited to the purpose, is barley.

In all cases of fermentation, the saccharine appears to precede the vinous fermentation. In the case of brewing from the seeds of the cereal grasses, it is usual, in order to promote the conversion of the fecula of the seeds into sugar, to cause them to germinate, and then suddenly to stop the germination. The seeds are then termed Malt, and can be preserved for use. This partial conversion of the matter of the seed into sugar is not, indeed, essential, for it appears that, without it, the saccharine fermentation will proceed under favourable circumstances.

The process of malting, then, is simply the production of a certain degree of germination, by which the starch or fecula of the seeds is partially converted into sugar. The grain is steeped for a time in cold water; the water is then allowed to drain off; the grain is spread out in a thick heap, in which it gradually heats and germinates. When germination has taken place to a certain extent within the grain, the further germination is checked by exposing the grain on a kiln, heated to such a degree as to destroy the vitality of the seeds. The malt, after being bruised, is put into a mash-tun as it is called, and hot water conveyed upon it. After this it is boiled, and, during the process of boiling, hops are added, and it is then cooled and fermented. Beer is therefore a wine, the soluble matter of the seed, instead of the pulpy matter of the fruit, being employed.

The last of the kinds of plants enumerated for yielding fermented and distilled liquors are the parsnep, the carrot, the beet, and other plants producing mucilaginous roots and tubers. The details of the operations differ from those in which the cereal grasses are employed, but the principle of the fermentative processes is the same.

By the vinous fermentation, it has been said, alcohol is produced, which may be obtained separately by the action of heat. This constitutes the art of distillation; and the substances which are capable of undergoing the vinous fermentation are capable of yielding alcohol by distillation.

Many plants not enumerated here are capable of producing fermented and distilled liquors. Thus, various common grasses yield them in considerable quantity; and some berries, as those of the mountain-ash, ferment as easily as the juice of the grape.

XI. PLANTS CULTIVATED FOR THEIR USES IN DOMESTIC ECONOMY AND THE ARTS.

The plants cultivated for their uses in domestic economy and the arts constitute a numerous class. They often yield good returns of profit; but they are rarely cultivated in the fields, and for the most part they fall more within the province of the gardener than the farmer. Those which may be here pointed out are,—

1. Dipsacus Fullonum—Clothiers' Teasel.
2. Sinapis nigra et alba—Black and White Mustard.
3. Coriandrum sativum—Coriander.
4. Carum Carui—Caraway.
5. Glycyrrhiza glabra—Smooth Liquorice.
6. Lavandula Spica—Common Lavender, and other Labiatæ.
7. Rosa rubiginosa, and other substitutes for Tea.
8. Cichorium Intybus, and other substitutes for Coffee.

Clothiers' teasel is cultivated in various districts of England for the raising of the nap on woollen cloths, which is done by the crooked awns of the head. For this purpose, the heads are fixed to the circumference of a broad wheel, which is turned round, while the cloth is pressed against them.

The clothiers' teasel is a plant growing several feet high, and terminated by the large head, which is employed in the manufacturing process. The seeds are sown about the beginning of April, on soil well prepared. The general mode of culture is broadcast, though the row system would seem more suited to the plant, which requires cleaning and hoeing during its growth. In the common practice, the plants are hoed out to the distance of 12 inches from one another ; and they are kept free of weeds by hoeing until the plants begin to shoot, which is in the summer of the second year. In proportion as the heads become ripe, they are cut off with a portion of the stem, and are then placed in a shed until they are dry. This crop may yield a good return, but it is necessarily of limited culture.

The Black and White mustard are plants cultivated for their oils. They are likewise applicable to other purposes, and in an especial degree to the making of the well-known condiment, mustard, which is in use in many countries.

Both these species are annual ; they admit of easy culture, and ripen their seeds early in autumn. They may be sown in rows on a flat surface like corn, the distance between the rows being 12 inches, so as to allow a sufficient space for the hand-hoe. They require no other culture than weeding during their growth. When reaped, they are tied in bunches and left a few days to wither, and then they are stacked to remain till they are required for use.

It is the black species which is chiefly ground into flour for mustard ; although the white, which is less pungent, is frequently mixed with it. Both are mixed with the wild mustard, and wild radish ; but the adulteration is not otherwise hurtful than as it is a fraud upon the consumer.

Several species of umbelliferous plants are cultivated chiefly for the aromatic flavour of the seeds. Of these are Coriander and Caraway.

Coriander is an annual plant, supposed to be a native of the south of Europe, but now naturalized in England. Its leaves and seed-vessels are strongly scented. Its seeds have an aromatic taste, and are used for confectionary and seasonings of different kinds. They are employed by distillers and rectifiers for flavouring spirits, and by druggists for various purposes. The plant is cultivated in Essex and other parts of England, and ripens its seeds in the same year in which it is sown. But it is common to sow it in September, when it is ready early in the following autumn. It is sown broadcast, although like many similar plants it may be cultivated in rows.

Caraway is of the same class of plants with respect to its uses; but it is a biennial plant, and is frequently sown with corn, the corn being reaped in the first year, and the caraway in the second. The seeds of the caraway are imported in large quantity from Holland. It is a native plant, and admits of easy culture.

The Smooth Liquorice is a leguminous plant, the roots of which yield a sweet and mucilaginous substance, which is employed in medicine and for other purposes. It is cultivated in some parts of England. It requires a light soil, deeply dug, and well prepared. The plants are cultivated from sets, in rows, 3 feet distant. They are tilled by the horse and hand hoe, and after three summers' growth the roots are taken up for use. There is a great demand for the produce of the liquorice plant, which, amongst other purposes, is used largely in the brewing of porter. The extract from the root is usually imported from Spain in rolls or cakes.

Lavender is cultivated chiefly for the odour of its flowers, which is obtained by distillation. It yields an oil, which is employed in some of the arts. It is a perennial plant, and is easily cultivated. Various other species of the mint family, as sage, marjoram, thyme, and peppermint, are valued on account of their tonic or aromatic properties, and are cultivated on the small scale on that account.

that are imported in
the infusion of which forms a soothing
certain countries. China and Tar-
quantity.

tea-plant seem to owe their grateful action
system to their stimulant properties. Many substitutes have been used, and are mixed largely with the tea consumed in this country, but none of them possesses the properties of the tea-plant of Asia.

The substitutes are the leaves of some of the plants of the rose family, as the *Rosa rubiginosa*, sweet-brier, and *Rubus arcticus*, common dwarf bramble: of some of the currant tribe, as *Ribes rubrum*, black currant: of some of the almond tribe, as *Prunus spinosa*, the sloe: of some of the mint family, as sage and balm: and of some even of the heaths and ferns. In the United States, the leaves of the sweet-smelling golden rod, *Solidago odora*, have been found to be a grateful substitute for tea.

The Coffee-plant, *Coffea arabica*, yields a berry, whose decoction forms a well known beverage, the use of which has been derived by us from Asia. Europe is now supplied in immense quantity with the berry of the coffee-plant from the islands of the West Indies. This decoction is, like that of the tea plant, grateful to the palate, and produces an exciting action upon the system. Many substitutes have been used, but though generally nutritive and wholesome, none of them possesses the flavour and properties of the *Coffea arabica*.

The best of the substitutes for coffee are the seeds of certain leguminous plants, which may be prepared by roasting in the same manner as coffee. Two of these may be mentioned:

1. *Astragalus bœticus*, Bœtian Milk-vetch, a plant which is cultivated in several parts of Europe, and used in the same manner as coffee.

2. *Lotus tetragonolobus*, Purple Winged-pea. This plant is cultivated in Spain for the like purpose. It produces beautiful scarlet flowers, and is remarkable for its winged legumes.

But the plant which at present attracts the most attention as a substitute for Coffee is the Succory, *Cichorium Intybus*, which is also cultivated for forage. It is the root of the plant which is used. It is mixed largely with the coffee consumed in France. It is believed not greatly to injure the flavour of the coffee, and some even, from habit, prefer the mixture.

XII. PLANTS CULTIVATED FOR THEIR WOOD.

The plants usually cultivated for their wood are divided into two great classes. 1*st*. The *Coniferæ* or Fir tribe, called also Resinous trees, and sometimes Soft-wood; and, 2*d*, the *Amentaceæ* and other tribes, frequently termed Hard-wood.

Trees of either class may be raised directly from seeds in the places which they are to occupy; but experience shows that it is generally more convenient to raise them in some place where they can be tended with care during the first stages of their growth, and, when they have acquired sufficient strength and size, to transplant them to the places where they are finally to grow.

In this country the care of the nursery has long become a distinct profession, and it is the natural effect of a division of labour that it should be so. Convenience will cause the greater number of planters to resort for their supplies of tree-plants to those who devote their attention to the raising of them. But where planting is to be carried on upon an extended scale, the planter may form his own nursery, in which case he has the means of raising his trees with more economy, and on soils more similar to those on which they are to be ultimately cultivated.

A nursery of this kind should consist of soil of a medium degree of fertility, the extreme of too great richness, or too great infertility, being avoided. The soil, too, should be of the lighter kind rather than of the stiffer, because the lighter soils are better suited than the stiffer to favour the growth of greater diversity of the kinds of the cultivated trees.

The situation of the nursery should be somewhat airy, without being too much exposed. To prepare the soil, it should be deeply trenched and thoroughly cleaned of the roots of weeds. If the land be not of itself fertile, it should receive a moderate manuring of lime and dung; for, although every thing like forcing forward of the plants is to be avoided as a great error in practice, care is to be taken that the land shall possess a sufficient degree of fertility to nourish and bring them forward.

The seeds of the trees to be cultivated, are first sown in what are termed the seed-beds. These may be made about 4 feet wide, with little paths for passages between.

The ground of these beds being carefully digged and rendered smooth by the rake, and a little of the surface-soil being laid aside for the purpose of covering the seeds, these are to be scattered evenly on the surface, and a light wooden roller then passing over it, the earth, which had been laid aside, is to be spread carefully and equally over the seeds.

The seeds of resinous trees must be lightly covered, and so also must some of the hard-wood kinds. Those of the larch, the Scotch or wild pine, and the spruce, should be covered about a quarter of an inch, and sown in the month of April; whilst those of the oak, the ash, the chestnut, the sycamore, and others, may be more deeply covered and sown at an earlier season. But some of the hard-wood kinds require to be sown at a later period, on account of their being subject to injury from frost; and some may be sown in summer and autumn.

The young plants remain in the seed-beds for one or two years, during which period they are termed *seedlings*. Some of the hardier resinous species, as the larch and the wild pine, may be transplanted at once from the seed-beds to the place which they are to occupy in the forest; whilst others, including several of the resinous, and all the hard-wood kinds, are first transplanted into lines in another part of the nursery, where they remain for one or more years, and then are transplanted to their place in the forest. The most of the resinous trees, when they are to be transplanted into the nursery lines, may be one year's seedlings; others of the resinous, and all the hard-wood kinds, should not generally be less than two years' seedlings before being transplanted to the lines. The transplantation from the seed-beds to the nursery lines may take place in autumn, after the descent of the sap, or in spring, before vegetation has commenced. The operation may be performed by the spade, but is often performed by the dibble. The plants are set at such distances in the rows that the horizontal branches of the young trees shall not interfere with one another. In transplanting, no part of the root should be lopped or shortened by the knife, nor the roots doubled in putting them into the ground; and care should be taken in planting, where the dibble is used, that the root shall be fixed firmly without being compressed at the neck.

Certain kinds of tree plants, instead of being propagated by seeds, are propagated by cuttings, consisting of a portion of the shoot of the previous year's growth, 12 or 15 inches long. These cuttings are planted by thrusting one end a few inches into the ground. This is the manner in which willows and certain poplars are raised.

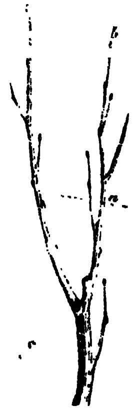
Certain kinds again are best propagated by layers. This practice consists in bending down the branches of a growing tree, fixing them in the ground by means of crooked pins of wood, and covering them partly with earth. In this state the covered part quickly shoots forth roots, and the branch being then separated from the parent tree, becomes a distinct plant.

But in the case of the greater number of species, the practice is to sow the seeds in the seed-beds in the manner described. The hardier pines are often planted at once, as has
been said, when seedlings; whilst others of the res
one plant will
cies, and most of the hard-wood, are not planted
until they have been one or more years in the
where they extend their roots, and acquire str

During the period in which the plants re
they are to be kept free from weeds. Th

at this early stage, further than to the extent of causing the leading or principal ascending shoot to preserve its ascendancy over the lateral and more horizontal ones, so that the plant shall not become what is termed forked, as in the figure. This may be simply effected by shortening one of the branches as at *a*, or by simply nipping off the terminal bud of the branch at *b*, by which means its lateral growth will be interrupted, and the main stem permitted to preserve its ascendancy.

Fig. 174.



The next operation to be performed is that of planting. For this purpose the ground is to be enclosed by an efficient fence, and freed, when necessary, of surface water, by open drains traversing the space to be planted: and no further preparation is usually required than this fencing and carrying off of the surface water. It is not necessary to dig or manure the ground as for common crops. Nevertheless, when it is wished, from any cause, to hasten the growth of wood, and when expense is less regarded than accomplishing the purpose intended, the land may be trenched or even manured. This will hasten the growth of the trees, and render the failure of plants less frequent; but it is a method of forest culture which has narrow limits, and which is impracticable, on account of the expense, over the greater part of those lands which form the fitting subject of planting in this country. Were it necessary to cultivate land in this manner before it could grow trees, a great part of the waste land of the country now covered with wood must have remained unplanted.

The plants of the nursery, then, are to be transplanted to their place in the forest, which may be done in the case of some
species when they are seedlings, but which is to be done in the
may be tra greater number when they have remained one or
which they the nursery lines, and when they are said to be
several of th years, or three years transplanted, according
transplanted in summers which they have remained in the

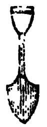
Two methods of planting may be practised. The one consists in making a slit in the ground with the spade, and putting in the plant: the other in digging a hole, in which the plant is placed, the earth being carefully shovelled over the roots.

The first of these methods may be practised with trees which are transplanted when seedlings, or even with pines and firs which shall have been a year in the nursery lines. The other method is practised generally with plants which have been for some time in the nursery lines, and whose roots accordingly have become extended. When the manner of planting is by slits, it may be performed thus:—

One person with a spade makes a deep slit in the ground, and then another slit crossing it. Having made the second slit, he bends down the spade until the slit becomes wide enough to admit the roots of the plant. An assistant, who attends with a bundle of plants, then taking one of them, slips it into the aperture formed by the spade. The spade being then withdrawn, the edges of the sods close upon the plant, the heel of the planter treading smartly upon the sod to bring the edges together. In this manner two persons may plant from 1000 to 1200 plants in a day.

Instead of the common spade, a small kind of spade, so light that it can be worked by one hand, may be used. When this instrument is employed, no assistant is required.

Fig. 175.



The person who plants carries a little bag of plants before him: with the spade in his right hand he makes a slit in the ground, and with his left he places the plant in the slit, and then he fixes the plant by a stroke of the heel. Practice renders this method of planting easy. One person, by this simple process, will set from 3000 to 4000 plants in a day, in such a manner, we are informed by those who have planted on the largest scale of forest culture, that scarce one plant will fail.[*]

Cruickshank's Practical Planter.

But this method of planting is suited only to seedling plants of not more than two years' growth; for when they exceed that age, and come from the nursery lines, the common spade must be employed, the strength of one hand not being sufficient to form a slit large enough to contain the root.

The other method of planting is performed by digging a hole by the spade. This is the method to be practised when the plants, by having grown in the nursery lines, have acquired extended roots; and the following is the method of proceeding:—

The holes are first digged in the number and at the distances required, the earth taken out of them being laid beside them. The trees are then planted, and two persons are employed at the work. The one places a plant in the centre of the hole, holding it upright by the top; the other with the spade shovels the earth all round it. The earth being then trodden down by the foot, the tree is planted; and it is a point of good practice that the sod or richer soil shall be laid next the roots. The rules to be observed in this operation are, that the holes shall be of sufficient size; that the plants shall be set upright, and be properly fixed in their position; and that no lopping away of the woody part of the root shall be permitted with the design of fitting it to the hole.

The distance to which the plants are to be set, is to be determined by the nature of the soil and situation. A common distance is from 3 to 4 feet. Trees ought in all cases to be planted at first much closer than they are intended to grow. The object of this is twofold:—1*st*, that there may be a provision against the failure of plants, and that those may be ultimately selected for standing which are the most vigorous and best formed; and, 2*d*, that the plants may mutually shelter one another. For, although by this close planting the temperature of the air, as indicated by the thermometer, is not increased, the shelter afforded against the violence of the winds is found to contribute to the healthy, straight, and rapid growth of the trees.

After a time, and by degrees, the superfluous plants are to be cut down. It is not, therefore, necessary that all the supernumerary plants should be of the more valuable kinds of trees, which would unnecessarily enhance the expense. The cheapest and quickest growing trees are the best suited for sheltering the others, and none are so well adapted for the purpose, at least in cold countries, as the fir tribe ; these being at once cheap, easily raised, and beyond every other kind suited to the sheltering of other trees, by their being evergreens. The firs thus intended for nurses, may be planted in slits, the hard-wood trees in holes.

The absolute necessity of sheltering by means of evergreens, doubtless only exists in a cold country, such as the more elevated parts of this island. But where the situation is low and the soil fertile, the sheltering by evergreens, may be dispensed with. Still, however, even in the most favoured situations, the plants should be set close together, both for the purpose of providing for contingencies, and for promoting the tendency to upright growth in the trees.

The period of planting is between the fall of the leaf in autumn, and the time when the buds expand in spring, when the vegetation of the plant is inert, that is, from about the middle of October to the end of February. Between these two periods, all forest plants may be transplanted from the nursery to their ultimate destination, the precaution merely being taken that the weather shall be mild, and the ground not frozen, when the transplantation takes place.

The next operations to be performed are those of pruning and thinning.

The natural tendency of many trees is to rise with a conical stem shooting forth lateral branches from the base upwards. Some species of trees, as most of the resinous and some of the willow and poplar kinds, do not generally tend to deviate from this form, the main trunk rising erect, surrounded from the summit to the base by smaller horizontal branches. But other trees, and these may be said to comprehend the greater part of the hard-wood, do not rise with the same regularity. Instead of one leading upright trunk, they send out many large boughs, which rival in size the principal trunk : such trees become forked near the base, and the principal trunk below is short, while the top is largely branched.

Now this is a form of the tree which, however conducive to beauty, is not so to utility. The main purpose of cultivating wood is for the timber, and the greater part of the useful timber of trees is contained in the trunk before it begins to shoot out into boughs. In the artificial cultivation of wood, therefore, it is important to produce as great a length of trunk, in proportion to the branched top, as a due attention to the natural habits of the tree will allow.

Further, it is important, for the obtaining of useful timber for the purposes of the carpenter, that the trunk shall be what is termed *clean* for as great a space upwards as possible. To understand the meaning of this term, when a branch shoots out from the side of the trunk of a tree, a part of the vegetable circulation is carried on through that branch: and hence there is at this place an interruption of the continuity of the circulation. The fibres of the branch lie in a different direction from those of the main stem, and this, when carried to a certain extent, is injurious to the texture of the wood. These twisted fibres frequently constitute, as it were, a distinct mass of wood within the body of the trunk, which takes greatly from the usefulness of the timber for the purposes of carpentry.

For these reasons, it is important that as great a part of the lower trunk as possible be freed from the lateral shoots.

Nature in part performs this process. As the tree rises in height the lower branches decay and fall off, so that there are few trees in which, even if left to themselves, there will not be a certain portion of the lower stems cleared of lateral branches. When trees are close together, this natural falling off of the lower branches takes place more quickly, and to a greater extent, than when they are distant from one another. Thus, in natural forests the trees rise with very tall upright stems, and are gradually divested of all their branches below to a vast height. It is from natural forests, accordingly, that our finest, tallest, and most valuable timber is derived.

But in the artificial culture of wood we cannot entirely imitate the natural process, and allow the lateral branches to fall off by themselves. We must in this case admit the air to the trees, by keeping them at a distance from one another: and under these circumstances, the tree tends greatly to shoot out into branches, and thus to produce a smaller growth of upright stems, as well as to have a smaller extent cleared of branches at the base.

In the cultivation of wood, then, we must generally resort to artificial means to give the tree the form which we wish it to possess. We must first endeavour to promote the upright in place of the lateral extension, and then to have a sufficient portion cleared of lateral branches.

Further, the lateral branches should be taken off at as early a stage in the growth of the tree as is consistent with its health; for it is to be observed, that when a branch shoots from a tree, the twisting of the fibres begins at the point where the branch had originated, and not, as from a cursory inspection might be supposed, from the surface of the stem.

As in the practice of pruning there are two distinct purposes to be aimed at; first, giving the vertical tendency to the tree, and, second, obtaining as great a portion as possible of clean stem; so there are two periods in the growth of the tree at which these things are to be attended to. The first in order of time, is giving the vertical tendency to the tree, and the second denuding it of its lower branches.

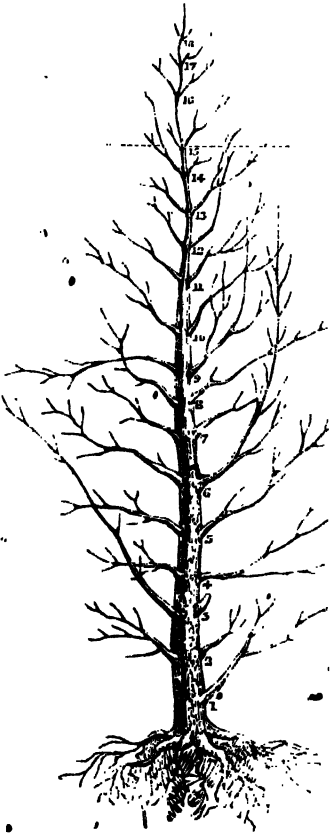
Until the tree has attained the height of 15 or 16 feet, the only end to be aimed at is to give it the upright tendency in question, and to prevent its becoming forked.

The pruning for this purpose consists in merely shortening such branches as may be rivalling the leading shoot, or stretching out laterally with a growth disproportioned to that of the others. Frequently the mere nipping off of the terminal bud will be sufficient to retard the growth of a branch; but in all cases it will be completely effected by cutting off the shoot as at *a*, Fig. 174, making it about half the length of the shoot above: this is the sole end in pruning during the first period of the growth of the tree; and, it is to be observed, that if a tree be of itself tending to grow upright and without forking, no pruning, even of this simple kind, is required. For of all pruning, it is to be observed, that it is a violence done to the plant, and is to be avoided as much as possible. By cutting off branches and leaves, we cut off organs of nutrition: We do not prune that we may increase the quantity of wood, for the operation has a directly opposite tendency and effect; but we prune that we may give to the tree that form which is calculated to produce the greatest quantity of timber in the proper place.

The other branch of pruning, and the next in the order of time, consists in denuding the lower part of the trunk of branches, so that there may be obtained a sufficient extent of clean wood. Although, for the reasons given, it is important that the taking off of these branches be at as early a period as possible, yet this must be done always under the conditions necessary to preserve the health of the tree. The tree should, in the first place, have attained sufficient strength and age to bear the being deprived of its branches; and, in the next place, the process should be carried on so slowly as not to affect the healthy growth of the plant, and so gradually, that it may have vigour to cicatrize, or cover with bark, the wounds that have been made upon its surface. The period when we may safely commence this process of denudation is when the tree has attained the height of 15 or 16 feet.

Now, every tree adds to the length of its leading shoots and branches from buds which grow on the ends of the shoots. Every year a new shoot is made from each of these buds, of a length proportioned to the vigour of growth of the plant. The shoots thus formed in one year, produce each a bud, which, in like manner, produces a shoot in the following year; and thus, while the tree is growing, there is a continued increase of the length of its leading shoots and branches. Further, when the annual shoot of any branch is produced, there is usually sent forth at the place where it originates one or more lateral shoots, so that there is a succession of branches, or tiers of branches, from the base to the summit. Were these lateral branches not to fall off, we could, by means of them, ascertain the age of the tree; and in the case of many of the Coniferæ, we can frequently ascertain the number of years which they have lived, or that each individual branch has taken to grow, from the number of these annual shoots alone. A knowledge of this mode of growth will conduct us to a simple rule in practice for removing, without violence, the lower branches of the trunk.

Fig. 176.



When we commence this process of pruning off the branches of the stem, let us cut off the lowermost branch or tier of branches, that is, the branch or branches of one year's growth, and no more: in the second year let us cut off a second tier: in the third year a third tier; and so on. In this manner, while the tree in each year makes one shoot vertically, the lateral shoots of another year are cut off below. Thus, in the annexed figure, the tree having made 15 shoots, and having risen, we will suppose, to the height of 15 feet, we commence the process of pruning, by cutting off the lowermost branches or set of branches 1. The tree then makes a shoot from 15 to 16, so that while we have cut off the lateral shoots of one year, another year's vertical shoot will be made. The next year we prune away the branch or branches 2; and again the tree makes a shoot from 16 to 17. In the third year we cut off the branch or branches 3, the tree making again a shoot upwards as before, to 18; and so we take off each year the lateral shoots of one year, and never more.

By this method we shall gradually denude the stem of its lateral branches from below upwards, while it is increasing in vertical growth. The extent of cleared trunk will thus gradually become larger in proportion to the uncleared portion or top. Thus, suppose that we begin to prune when the tree has made 15 years' shoots, then, when it has made 30 years' shoots, we shall have cleared off 15: that is, half the height of the tree.

Now, when we have cleared half the height of the tree, or a very little more, we should pause in our further operations, and mark its state of growth. If it continue to grow vigorously we may resume our operation of close pruning, but at longer intervals than before, so as never in any case to have more cleared away than one-half, or at the utmost three-fifths, of the height of the tree, and never taking off more than one year's lateral growth of branches in a season.

Every tree, it is to be observed, must possess a sufficient top; that is, it must extend horizontally as well as vertically so as to bear branches and leaves. The leaves are organs of nutrition of the plant, essential to the healthy exercise of the vegetable functions; and we must be careful to deprive it of no more of these organs than consists with our purpose in pruning. Now, by proceeding slowly in this gradual manner, never taking off more in any one year than the growth of one year's lateral branches, we shall not usually interfere with the healthy growth of the tree, but shall always leave it a sufficient power of expansion at top to afford it the means of nutrition and growth. Further, by never cutting off more at a time than the growth of one year, the tree will generally have vigour to cicatrize the wounds that have been made upon its trunk; whereas, were we to lop off many branches at a time, according to the practice too prevalent, the tree might not have vigour to cover them with a fresh growth of bark, and thus the wounds might remain, to the lasting injury and frequent destruction of the tree.

In pruning in this manner, the branches are to be cut off quite close to the stem, so that the bark may quickly cover the wound; and although trees may be pruned in summer, the fittest period of pruning, as of all operations upon the living plant, is when vegetation is inert; that is, from the fall of the leaf to the period of the ascent of the sap in spring.

Thus, then, the operation of pruning may be said to be begun in the nursery, but at that time with an extreme degree of temperance, all the end of pruning at that early period being to prevent the plant from becoming forked. When the trees are transplanted to their ultimate situation, we may examine them in the third, or at latest the fourth, year afterwards, and then, if more than one leading shoot is formed on any tree, we are to select the best, and shorten the others to about half the length of that which had been selected. And in like manner, when any branch or set of branches is seen to be extending laterally, with a growth disproportioned to that of the others, then, by merely shortening them, the tendency to the lateral extension will be sufficiently checked to allow the other branches to extend in an equal degree. And should we find that all the branches of a tree are tending to extend too much laterally, by merely shortening them in a slight degree, we shall give the ascendancy to one leading shoot, and so promote the upward tendency; and this is all the pruning required until the tree has attained, as has been said, the height of 15 or 16 feet, when the process of pruning the lower branches is to be begun, and carried on by the slow process described. But, even after we have begun the process of close pruning, we may still observe that the tree is ascending vertically, and if required, give this tendency from time to time by shortening any of the lateral branches.

It is not essential to the success of this method of pruning, that it be carried on every year. It will be sufficient to approach as near to the perfect practice as circumstances will allow, observing merely the general rule that *not more* than the growth of one year shall be taken off at a time, and that the *process shall not be carried further than to the clearing off of three-fifths of the height of the tree.*

The method of pruning by the shortening of the lateral branches, was brought into notice in England by the writings of Mr Billington, who had charge of a portion of the Royal forests; and it was further developed and explained, with the addition of the gradual denudation of the lower branches, by Mr Cree in Scotland. To these most deserving individuals is due the merit of having introduced, and to the latter that of having perfected, a system of pruning very greatly superior to that which had been before in use.

Pruning, as it is commonly practised, can scarcely be said to be founded on any principle. Branches are lopped off without limit or caution, and thus the growth of the tree is injured, and wounds formed upon its surface which are never afterwards cicatrized. Often in the case of the youngest trees, we see the entire branches of successive years' growth lopped off in a season, and nothing left but a bush at the top. By this system of mutilation, millions of trees are sacrificed. A great proportion indeed of the whole cultivated wood of the country is annually destroyed, and it were better that the pruning knife were never used at all than thus misapplied. The practice so common has probably been derived from that of the garden; but it is to be observed that, in the garden, the purpose in pruning is to repress the growth of wood and produce that of fruit; and the principle, therefore, is in no degree applicable to the pruning required in the forest.

The principal instruments to be employed in pruning are a sharp knife, chisels with handles for reaching the higher branches, and sometimes a small saw for the larger branches. The hatchet is on no occasion to be used in pruning. The following figures represent the chisel and the saw. The saw

Fig. 177.

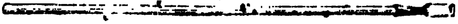
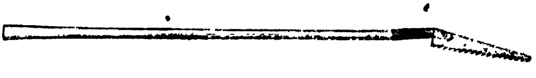


Fig. 178.



here shown is the Indian saw, which is made to act by being pulled towards the operator, in place of being pushed away from him like the common saw of Europe. By being fixed to a long handle, this instrument is adapted to the cutting off of the higher branches.

When the proper direction has been given to the growth of the tree, and the lower branches have been pruned to the height to which it has been thought expedient to carry the operation, art has done all that it can do to render the tree useful. The natural growth of the tree must effect the rest. The trunk will increase in diameter by the addition of concentric layers of wood, yearly formed between the bark and the stem. The longer a tree stands while in a growing state, the thicker will its trunk become, and the more valuable. It makes wood rapidly, to use a familiar expression, when the trunk has become of good size; and it is an error, therefore, to fell wood which is intended for timber too soon.

In the pruning of forest trees, one of the most frequent errors committed is to delay the process till too late. By this delay the form of the tree is often rendered such that it cannot be restored; and the lopping off of large branches in the manner often practised, in order to give the tree a better shape, is for the most part attended with the evil of disfiguring it more, and enfeebling its growth. We constantly see those mistaken attempts to repair past neglect, by the lopping off of large limbs, the places of which the tree now wants vigour to heal. Vast numbers of trees are destroyed by this system of mutilation, when all further object in pruning is at an end. Sometimes a large branch may be lopped off when a tree is top-heavy, or when a branch is likely to be split, or for some other good reason. But it is an error, which must end in disappointment, to begin this system of lopping a full grown tree, with the design of compelling it to resume its process of increase when it has naturally ceased.

When a tree has been neglected, but is not yet so far advanced but that we may hope to restore it, we have merely to apply the principle of pruning explained to the case of the particular tree. We have to shorten the lateral branches which are forming forks, so as gradually to produce the upright tendency of the leading stem required. The rule is to proceed with the greatest temperance, taking care never to do too much in one season, lest, by depriving the tree of its branches, we enfeeble its vigour and impede its growth.

The process of pruning has been described, but there is another part of forest-culture coincident with pruning, and of equal necessity. This is the thinning out of the superfluous trees, so as to admit the air, and give room to the trees that are to remain. The trees, we have seen, have been planted greatly more closely than they are intended to grow, and many of them were designed merely to shelter the others during the early stages of their growth.

Whenever the horizontal, branches of trees begin to cross one another, the process of thinning should commence. This is to be done by cutting out such a quantity of the inferior trees, as shall allow a sufficient space between the remainder. The first thinnings of this kind will be of little value, and will not repay the expense of clearing them out. Yet it is necessary that they be cleared away, in order to allow space and air for those which are left.

From the period when this first thinning is made, the plantation should be gone over every two or three years, and the same process repeated, observing the simple rule that the boughs shall never be so close as to interlace. If the plantation consists of a mixture of hard-wood and resinous trees, the whole of the latter should have been cleared away by the time the wood is 14 years old or less, and the great mass of it long before. After this the hard-wood trees should be kept at the distance from one another of about half their height.

When a plantation consists entirely of resinous trees, they may be kept much closer together than in the case of hard-wood. Still it is important, in the case of the resinous trees, that the thinning be continued frequently, so that they shall not crowd upon one another. It is by neglect of this point that many thousand acres of cultivated wood become comparatively useless.

The most frequent mistake committed in the management of mixed plantations of resinous trees and hard-wood, is the allowing of the former to remain until they have choked and enfeebled the hard-wood. This is done with the design of allowing the resinous trees to remain so long that they may be of some value when cut down. This, however, is an error of practice, by which the value of the hard-wood is lessened, while the full value of the softer wood is not obtained.

The habits of the resinous trees and the hard-wood kinds are very different; and when the end proposed is merely the raising of wood for future profit, the two kinds will be best cultivated separately. It is not an exception to this principle that firs and pines are planted along with hard-wood. They are planted for the purpose of shelter, and they should be removed as soon as they have served this purpose. It is by allowing them to remain too long, with the design of combining the profit of the two classes of trees, that the hard-wood in many mixed plantations is stifled and rendered useless.

Again, when the end proposed is the profit to be derived from resinous trees, they are best planted without any mixture of hard-wood. In this manner a greater quantity, and of better quality, can be raised from a given space. They can be suffered to arrive at maturity, and then cut down when really of value; whereas, if mixed with hard-wood, they would need to be removed long before they had become of use.

And not only when ultimate profit is looked to should the two classes of trees be cultivated separately, but in many cases, in the planting of hard-wood, the same kinds of them should be planted together. Thus a forest of oaks will be more valuable if unmixed with other trees. Besides, the oak possesses the property of springing again freely from old stocks when cut down. In this manner, after being felled, the plantation is formed into coppice, and made to yield periodical returns at intervals of 25 or 30 years. In like manner, willows and poplars are best planted in groups by themselves. In this case, a greater number of them can generally be raised upon a given space in the situations suited to them: and some of the species of willows, by being cut regularly, may be formed into osier plantations, and yield successive crops.

These are considerations to be regarded when the end is the profit to be derived from the wood; but when the taste is to be likewise gratified, then the mixed plantation, with its varying tints and diversified forms of trees, may claim a preference over that which, on a mere calculation of profit, would be chosen.

Different species of trees, whether planted together in groups or intermingled with others, have each peculiarities with respect to the manner of their growth, the soils and situations to which they are suited, and, in some cases, the method of management. With these differences the forest planter should be rendered familiar. But the description of species and the manner of cultivating them, forms itself an extensive branch of rural economy, which would exceed the limits which could be assigned to it in an elementary work. The end proposed here has been to explain the general practice of planting, and the management of forest-trees, without entering into the lesser details, or into a description of the different species which are, or which may form, the subjects of cultivation.

The following may be enumerated as forest-trees adapted to cultivation in this country:—

1. Pinus sylvestris—Wild Pine.
2. Pinus Laricio—Corsican Pine.
3. Pinus Cembra—Siberian Stone Pi
4. Abies communis—Norway Spruc
5. Abies Picea—Silver Fir.
6. Abies nigra—Black Spruce.
7. Abies alba—White Spruce.
8. Larix europæa—Common Larch.
9. Larix pendula—American Black Larch.

These are all resinous trees, sufficiently hardy for forest culture in this country.

Of the hard-wood kinds there may be enumerated—

1. Quercus Robur—Common Oak.
2. Quercus sessiliflora—Sessile-fruited Oak.
3. Quercus Cerris—Turkey Oak.
4. Quercus alba—White Oak.
5. Juglans regia—Walnut.
6. Castanea vesca—Sweet Chestnut.
7. Æsculus Hippocastanum—Horse Chestnut.
8. Fagus sylvatica—Common Beech.
9. Carpinus Betulus—Hornbeam.
10. Betula alba—Common Birch.
11. Betula pendula—Weeping Birch.
12. Betula lenta—Black Birch.
13. Betula papyracea—Canoe Birch.
14. Alnus glutinosa—Common Alder.
15. Salix alba—White Willow.
16. Salix russelliana—Bedford Willow.
17. Salix triandra—Long-leaved Triandrous Willow (for osiers).
18. Populus alba—Great White Poplar.
19. Populus dilatata—Lombardy Poplar.
20. Populus tremula—Aspen.
21. Ulmus campestris—Narrow-leaved English Elm.
22. Ulmus suberosa—Common Cork-barked Elm.
23. Ulmus montana—Wych Elm.
24. Fraxinus excelsior—Common Ash.
25. Fraxinus americana—White Ash.
26. Fraxinus quadrangulata—Blue Ash.
27. Acer Pseudo-platanus—Sycamore.
28. Acer platanoides—Norway Maple.
29. Tilia europæa—European Lime-tree.
30. Tilia rubra—Red-twigged Lime-tree.

Of the class of smaller trees cultivated for underwood, the following may be mentioned :—

1. Corylus Avellana—Common Hazel.
2. Pyrus Aucuparia—Mountain Ash.
3. Cratægus Oxyacantha—Hawthorn.
4. Cytisus alpinus—Laburnum.
5. Ilex Aquifolium—Common Holly.
6. Prunus Laurocerasus—Common Laurel.
7. Prunus lusitanica—Portugal Laurel.

When it is wished to form a mixed plantation of these and other species, they are to be planted of the kinds and in the proportions which are best suited to the soil and situation.*

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* The following is an example of a mixed

The profit to be derived from planting will appear to** many **to be contingent and distant, and yet to expend capital on planting, may be to lay out money to increase at a high rate of interest. Planting, therefore, may be to the landed proprietor a mode of setting aside a fund for a future purpose, and

the spruce, and the wild pine, are designed to serve the purposes of nurses :

300 Oaks,	20/ per 1000.	L.0	6	0
100 Wych Elms,	12/6 ..	0	1	3
150 Ashes,	12/ ..	0	1	9½
25 Sweet Chestnuts,	25/ ...	0	0	7½
50 Beeches,	15/ ..	0	0	9
50 Sycamores,	12/6 ...	0	0	7½
50 Weeping Birches,	25/ ...	0	1	3
All these plants should be from 1½ to 2 feet high when planted; but not exceeding 2 feet.				
25 Bedford Willows, from cuttings,	10/ ...	0	0	3
25 White Poplars, from 3 to 4 feet high,	50/ ...	0	1	3
50 Hollies, from 9 to 12 inches,	20/ ...	0	1	0
50 Laburnums, from 2 to 3 feet,	20/ ..	0	1	0
50 Mountain Ashes, from 2 to 3 feet,	20/ ...	0	1	0
50 Hazels, 1½ foot,	17/6 ..	0	0	10½
50 Silver Firs, 1 foot high,	25/ ...	0	1	3
500 Larches, 1 foot high,	2/6 ...	0	1	3
500 Norway Spruces, from 9 inches to 1 foot high,	3/ ...	0	1	6
1531 Wild Pines, about 9 inches high,	2/ ...	0	3	0¾
3556, being 3½ feet apart,		L.1	4	8½
Expense of planting,—the willows, larches, spruces, and pines being put into slits, and the others in holes,		0	16	6
		L.2	1	2½

To this is to be added the expense of enclosing, which increases in a great ratio as the space to be enclosed is lessened. Thus, to enclose the following quantities of land, in the form of a square, with a stone-wall, at 1s. 2d. per yard in length, will be as under :—

Acres.	Total Expense.	Expense per Acre.
50	L.114 16 0	L.2 5 11
10	51 6 8	5 2 8
1	16 4 7	16 4 7

When the space to be enclosed, therefore, is 10 acres, the expense by the acre is about 2¼ times more than when it is 50 acres; and when the quantity is only 1 acre, it is about 7 times more. Hence the error of planting in patches. This may be done for shelter or embellishment; but when proan estate may be preserved to a family by capital wisely expended on this improvement.

But the profit is usually derived from planting land that is otherwise of comparatively little value. It is not the lands that will yield a good profit by cultivation that will yield a good profit by planting, but those that are otherwise little productive. Superior soils will produce more valuable wood; but, taking into account the loss of rent for the long period of the age of a tree, it is the class of soils low in the scale of fertility and value that usually yield the largest return for planting.

In the practice of forest culture we should take care that the work of planting be executed well. When we employ the common labourers of the country, the digging of the holes for the trees may be done by contract; but the putting in of the plants should be by days' labour, in order that the persons employed may have no interest in executing the work in an imperfect manner.

fit from the timber is looked for, the difference between planting on the large and small scale may make the difference between profit and loss in the plantation.

The expense of planting as above, per acre, is .	L.2	1	2¼
of enclosing, when the extent is 50 acres, .	2	5	11
	L.4	7	1¼

Now, the following calculation will show the amount of the cost of planting, enclosing, and the rent of the land, up to the period when the outlay may be expected to be repaid; that is, when the wood has arrived at maturity, and is fit for being cut down:—Let it be supposed that wood requires 60 years to reach the age of good timber, and that the land is worth 5s. per acre yearly in its original state, then, rating money at 5 per cent. compound interest,

the amount of 5s. yearly for 60 years is .	L.88	7	11
The expense of planting and enclosing, L.4 : 7 : 1½ for the same period, principal and interest, is . . .	81	7	5
	L.169	15	4

So that, if the wood shall be worth L.169 : 15 : 4 at the end of 60 years, the original capital and the loss of rent will have been repaid. But L.169 : 15 : 4 per acre would be a very low price of wood of 60 years' standing. Five or six times the amount, independent of the value of thinnings, might be expected to be derived; and, therefore, on the conditions supposed, the capital would be profitably laid out in planting.

[illegible] those that are of a proper size. It is an error to select plants because they are large. Such plants may perish or become enfeebled when transplanted from the nursery to the forest. Yet this is the kind of plants that inexperienced planters are apt to prefer. Care, too, should be taken that the plants selected be of healthy growth, and free from forks.

When land has been planted, the ground should be examined regularly for several years afterwards, and the plants that may have died, replaced. The ground should be kept free of stagnant water, and carefully defended from trespass during the early stage of the growth of the trees.

XIII. PLANTS CULTIVATED OR USED FOR FORAGE OR HERBAGE.

Plants cultivated for forage are those which are mown, and used, either in a green or dried state, as the food of animals. Plants cultivated for herbage are consumed upon the ground where they are produced. Certain kinds of plants are better suited for forage than herbage. But many are adapted to either purpose, and therefore no distinct line can be drawn between the two classes.

The plants usually cultivated or employed for forage or herbage, are—

1. The Tare, and other species of Vetch.
2. Lucerne, and other species of Medick.
3. Sainfoin.
4. Wild Succory, and other plants producing leaves suited for forage.
5. Clovers, Vetchlings, Melilots, &c.
6. Heaths, Sedges, and Rushes.
7. Rye-grass and other grasses.
8. Burnet, and other plants producing herbage.

1. The Tare.

The Tare,* *Vicia sativa*, is one of the most esteemed of the leguminous forage-plants of this country. It is an annual plant, indigenous, and hardy. There are several varieties of it, one of which is distinguished by producing yellow seeds.

The tare, by being sown in autumn or in spring, acquires habits so different, that many have supposed the spring and winter tares, as they are called, to be different species. They are, however, the same species, and do not even constitute botanical varieties; but, from the different habits of ripening which they acquire, they should be always sown at the periods to which they are respectively suited; that is, the winter-tares should be sown in autumn, and the spring-tares in spring; for experiments have shown, that the spring-tares sown in autumn will frequently perish in the first frosts, while the winter-tares will continue uninjured. This requires the more attention, as the seeds of the two kinds are so similar that no means of discriminating them exist.

When tares are cultivated for green food at a late season, they are to be sown in spring: and in order to procure a succession of cuttings during the months of summer and autumn, portions of the ground should be sown at intervals from the middle of March till the end of May.

When tares are to be sown in autumn, for early feeding in the ensuing season, the land frequently receives only one ploughing, after which the seeds are sown in the usual manner, and harrowed. A little further tillage, however, would be beneficial, so as thoroughly to prepare the ground.

When tares are sown in spring, the land should receive a ploughing before winter, as in the case of pease and beans. It should be cross-ploughed again in spring, and well-harrowed, and receive a second ploughing if possible; for it is always well to prepare the surface carefully for the seeds of this plant. After they are sown, the land should be rolled, to facilitate the subsequent action of the scythe. If manure had been required for the crop, it should have been applied in the previous autumn.

Tares should always be sown on land which is in good condition and clean. It is a great error to sow tares on land which is not in this state. The tares are considered in many places as a kind of bye-crop; hence they are left to struggle with weeds, and many important advantages attending their cultivation are lost. The management of the tare in England is much superior to that pursued in Scotland.

The quantity of seeds sown may be from 3 to 4 bushels to the acre. When the crop is sown for its seeds alone a smaller quantity will suffice, as 2½ bushels to the acre.

It is common to mix a portion of some of the cereal grasses with the tare, the effect of which is to increase the quantity of fodder; the stems of the grasses rising above the foliage of the tares, and both growing without interrupting one another. For winter-tares rye is best suited, for spring-tares oats or barley.

Tares, when used as green forage, are cut after the pods are formed, but long before the seeds become ripe. Tares, therefore, being in the class of crops not allowed to mature their seeds are not exhausting to the soil. On the contrary, with relation to the farm, they are to be considered as restorative crops, from the quantity of manure which the consumption of them affords. They are exceedingly nutritious, and supply a larger quantity of food for a limited period than almost any other forage crop.

The usual mode of sowing tares is broadcast, though they are better sown in rows, like the pea and the bean. This, indeed, is by no means so essential to the success of the crop as in the case of the bean and pea, for the produce of the tare is chiefly the stem and leaves, and the pods and seeds are of little comparative importance; the admission of air, therefore, for the swelling of pods and seeds is not necessary. The plants, too, cover the intervals of the rows quickly, and so do not admit of much time and opportunity for tillage during their growth.

Tares are chiefly cultivated for green forage; but they may be also cultivated partially for their seeds. In this case, the mode of culture is the same as that of the pea. The land should not be too rich, so as to cause them to run to straw instead of producing pods; and it is a good practice to mix a small quantity of beans with them, to support and keep them from trailing on the ground. The beans, from their difference of size, are easily separated by riddles from the tares. In the practice of the farm it is common to cultivate tares for green forage, and merely to reserve that part of the crop for seeds which is not used in this manner. They are then reaped, stacked, and dressed, like pease.

When the tare is cut very early, it may rise again and produce a second crop; and even a third cutting is sometimes obtained. In the northern parts of the island, the farmers scarce ever attempt to produce more than one crop in the season.

Tares are sometimes consumed by penning sheep upon them; but the better practice is to feed the sheep from racks. When the larger animals are fed on this food, it should always be supplied to them from racks in houses or yards.

All the animals of the farm are fond of this legume, and all thrive upon it in an eminent degree. Hogs may be fattened entirely upon it. It is suited to milch-cows, causing them to give more butter than any other species of food, and it is employed extensively in the feeding of horses. All the English agriculturists are impressed with a high opinion of the value of tares. They are not only casually employed, as in Scotland, to fill up the intervals between the cuttings of clovers, but they are often the principal source of feeding from the month of May to November.

There are several species of vicia, with broad leaves resembling those of beans, cultivated in Germany for the same purposes as the tare:

1. Vicia narbonensis—Narbonne Vetch.
2. Vicia platycarpos—Broad-podded Vetch.
3. Vicia serratifolia—Saw-leaved Vetch.

But none of these species is equal in productiveness to the common tare.

Another of the genus *Vicia* is *Vicia pseudo-cracca*, Annual Tufted Vetch. This species is of very luxuriant growth, but flowers at a late season. It is, as yet, untried in the agriculture of this country. It might, perhaps, supply a desideratum, namely, the affording of a large quantity of green forage after the pastures have begun to decay in autumn, and before the turnips and similar plants are ready for use.

Vicia biennis, Biennial Vetch, is a native of Siberia. This species is of luxuriant growth, and comes early in spring. It was cultivated by Miller so long ago as 1759, and recommended by him as a plant of great promise: but no experiments upon it on the large scale are recorded. Its stems have a certain degree of hardness, and its leaves a somewhat insipid taste.

Vicia sylvatica, Wood-Vetch, is perennial. It grows in woods with a stem from 3 to 5 feet high, climbing by its tendrils, and bearing beautiful little flowers streaked with bluish veins. The wood-vetch, as its name denotes, is truly the inhabitant of woods, and, when removed to exposed situations, its size and productiveness diminish. For this reason, perhaps, it is not adapted to cultivation.

Vicia Cracca, Tufted Vetch, grows in hedges and bushy places, climbing also by tendrils, and bearing numerous purple flowers. It is, like the last, perennial, but is more productive when removed from its natural habitat. It is, however, late in growing, and appears to be much inferior in usefulness to the clovers. It grows on soils of low fertility.

Vicia sepium, Bush Vetch, is a plant growing also in hedges and bushy places. It is perennial, flowers early, and yields a good weight of produce. Although its natural habitat is bushy and shady places, it grows in cultivated fields, and has a somewhat wide range of soils. From these characters, and the trials that have been made, there is reason to infer that the bush vetch would be a beneficial addition to the cultivated herbage plants of this country. There is great difficulty in procuring its seeds in its wild state, from its dispersing them as soon as ripe; a character, however, which would probably be changed by cultivation, as happens in the case of other wild plants.

Of the important genus *Vicia*, about 100 species have been enumerated by botanists, and many of them seem to be highly deserving of experiment for their economical uses.

2. Lucerne.

This plant, *Medicago sativa*, has been cultivated in Spain, Italy, and the south of France, and on all the northern shores of the Mediterranean, time out of mind. It is cultivated in the countries of the East. It was familiar to the Greeks and Romans, from whom we derive minute accounts of its nature, properties, and culture.

Lucerne has a perennial root, and grows, when cultivated, from a foot and a half to two feet high and more. It is covered with leaves, downy below, and slightly so on the upper surface: it bears a flower of a fine purplish-violet: it flowers in June and July.

The cultivation of lucerne has been long stationary or retrograde in the British islands. In Guernsey and the islands of the Channel it maintains its reputation, and justly so, the climate and soil of these islands being suited to the plant. For the same reason, it is esteemed and partially cultivated in Kent, and some of the southern counties of England.

The soil adapted to lucerne is deep and of the lighter class, with a free or kindly subsoil. When these circumstances do not exist, it is better not to attempt the cultivation of lucerne in this country.

Two methods of raising this plant have been recommended and practised. The one is sowing it broadcast in spring, sometimes along with a corn crop, in the same manner in which we sow clovers, and sometimes without a crop; and the latter is the better practice, lucerne not being suited to grow freely under the shade of other plants. The other method of cultivating lucerne is in rows. Lucerne, like other cultivated forage plants, gradually gives place to the grasses and hardier indigenous plants. When cultivated in rows, and carefully hoed, these native plants can be kept down, and the lucerne preserved for a long period in the ground. But, when sown broadcast, this cannot be done in the same degree, and the lucerne then does not generally endure beyond nine or ten years. This is the main advantage which the row system possesses over the broadcast, in the cultivation of this plant.

The best period of sowing lucerne is at or before the middle of April. When sown broadcast, the quantity of seeds to the acre may be 16 or 18 lb.; and when sown in rows, 10 lb.

The soil should be well prepared by deep ploughing, and a previous summer-fallow, or fallow-crop such as potatoes, turnips, or carrots. But when it is wished merely to possess a few acres of lucerne for the convenience of soiling, it is better to have the soil deeply trenched and prepared like a garden bed, and at the same time well manured with dung and lime.

When drilled, the rows need not be more than 18 inches apart, which will give room for tilling the intervals by the horse and hand hoe.

After the seeds are sown, care must be taken to keep down, by means of the hoe, all weeds that spring up amongst the plants and in rows.

In the month of August of the first year when in flower, the crop may be mown, and, after this first cutting, the shoots may be kept down by a slight pasturing with sheep, but not while the soil is wet, nor continued till a late period.

Early in the following spring the ground is to be horse or hand hoed, so that all weeds may be kept down, and the earth stirred about the roots of the plants. In the month of May the crop will be ready for the first cutting.

After being cut, it is to be horse-hoed in the intervals of the rows. It will now grow very rapidly; and, when ready for cutting, is to be cut again, and, after each cutting, hand-hoed. In this manner it may be mown four or five times in the season.

It does not, however, arrive at its full growth till its third year, after which it will yield a large return in rich and early foliage. But it requires to be manured at intervals, as every third year. ' The manure may be farm-yard dung, spread upon the surface after the last cutting in autumn, or early in spring.

When the system of broadcast is adopted, the difference in the method of tillage is, that, in place of the horse and hand hoe, the common harrow is used, which, passing over the surface, stirs the soil about the roots of the plants, and drags up and destroys weeds; the lucerne itself, having a strong root striking downwards, is not torn up by this rough treatment, but on the contrary, is benefited by the stirring of the soil round its roots and stems.

This plant is eminently wholesome and nutritive. It is well suited for milch cows, causing them to yield good and abundant milk. It is perfectly adapted to the feeding of horses, and this indeed is one of the most common purposes to which it is applied. It may be used with the like advantage for the soiling of any kind of stock. It is valuable for the early feeding which it supplies, being in this respect considerably before the clovers. When we possess a portion of lucerne, therefore, we can begin to soil at an earlier period than could otherwise be done.

Portions of lucerne cultivated on the small scale, and with care, have been found to maintain a great number of animals; and hence its advocates have formed an erroneous estimate of its fitness for extended cultivation. But although lucerne is very productive in itself, it is not a species of crop which is suited to general culture in this country. It takes three years to arrive at maturity, and it is very liable to fail from the attacks of insects in the first year of its growth. It requires manure to be applied to the surface to keep it productive, and this is a wasteful mode of applying the manures of the farm. It requires also a deep rich soil, which is not always to be found. The limit, then, to which it seems beneficial to confine the cultivation of lucerne, is to that of a small portion, for the purpose of supplying the place of common forage plants in early spring, and of using it in addition to these during the summer. With this design a few acres may often be very conveniently applied to its production; but beyond this its cultivation can rarely be recommended in this country. Where the alternate system of husbandry is pursued, a better method of raising green food for stock is practised, than applying any part of the farm constantly to that purpose.

The most productive of the genus *Medicago*, is the species which has been described; but there are others which are cultivated. Two of these may be mentioned:—

1. *Medicago falcata*, Yellow Sickle Medick. This is a smaller plant than the last, and is suited to soils lower in the scale of fertility. It is cultivated on the poorer soils of Switzerland, and in different parts of Europe.

2. *Medicago lupulina*, Black Medick, so termed from the black colour of its seed-vessels when ripe. This is sometimes termed Yellow Clover, and sown by farmers under that name. It is also termed Hop Trefoil, from the resemblance of the heads of its flowers to those of the hop. It is an indigenous plant, and grows naturally on dry and gravelly soils. It is a biennial when cultivated. Like most of the leguminous plants it is nutritive, and readily eaten by pasturing animals. It may be cultivated for forage or for herbage, when the land is to remain only one year in grass.

3. SAINFOIN.

Sainfoin, *Onobrychis sativa*, has a perennial root, is a native of Britain, and is extensively cultivated for green food in the chalk and sandy districts of England and France. Although this species has an extensive range of the lighter class of soils, it is yet, in a peculiar degree, adapted to the calcareous; hence it is found growing naturally in many open downs and hilly pastures where the chalk-formation exists.

Sainfoin is a deep-rooted plant, with a branching stem, bearing spikes of beautiful flowers. It grows wonderfully on rocky soils, stretching its roots to a prodigious depth amongst the crevices of rocks and open strata. It is, in truth, on dry rocky soils that the chief advantages of the cultivation of sainfoin are seen. On a chalky rock, covered with only a few inches of soil, it will thrive and grow for many years with vigour, where neither corn nor cultivated herbage plants would cover the surface. Like lucerne, although in a lesser degree, it is choked, and ultimately extirpated by the prevalence of the grasses; but in a soil perfectly suited to it, as in a chalky down, it will have a duration perhaps as long as any other plant. Although best adapted to the calcareous soils, it will grow upon any light soil which has a free or open subsoil; but on moist clays it will only last a few years, sometimes not above two.

Sainfoin may be sown with a crop, in the same manner as the clovers and grasses. In the following season, it may be mown for hay or green forage, although it does not attain its full maturity until the third year. When this mode of management is adopted, the sainfoin should be mixed with one or more of the clovers, of which the most suitable for the purpose is white clover, which will add to the weight of the produce, without materially interfering with the growth of the sainfoin.

When greater care is thought necessary, sainfoin, like lucerne, may be cultivated in rows, being regularly tilled and horse-hoed during the summer, and manured at intervals, as every fourth or fifth year: but for the most part, it is not thought necessary to resort to this method of tillage, and the easier and more convenient practice of broadcast is preferred.

The seeds of the sainfoin are larger than those of the clovers; and when sown with the cereal grasses in spring, a little more care is necessary in covering them with the harrow and roller. The seeds should be of a good and tried kind, and perfectly fresh, for old seeds do not vegetate in a proper manner. The quantity, when sown broadcast, may be 4 bushels to the acre; when sown in rows, from 2 to 3 bushels. The best period of sowing it is in the month of March, although it is sometimes sown in February.

Sainfoin does not bear such frequent cutting as lucerne. When used for soiling, it may be cut twice; when used for hay, it should be cut once, and the aftermath depastured. Sainfoin may be used for herbage as well as for forage, and many farmers prefer depasturing it in the first year, so that in the second it may have attained its full growth before it is mown; and this is a good practice.

Sainfoin, when it is made into hay, should, like other leguminous forage plants, be cut just when it comes into full flower. It is not very apt to be injured by heating, and therefore may be put up more quickly than other hay plants. The produce in hay is generally reckoned from 1 to 2 tons to the acre, in districts where it is cultivated; and, considering that it is grown on inferior soils, and that it yields good aftermath, it will be seen to be a productive plant.

If ground is to be mown for successive years for forage, then, on such soils as are suited to it, scarce a better crop can be cultivated than sainfoin, which is easily grown, hardy, and productive. But, with regard to this particular mode of cultivation, it cannot be at all commended. It is not the most beneficial mode of raising crops for forage; for, independently of the smaller produce, the keeping of land under any one kind of crop, and manuring it upon the surface, is to deprive the cultivated land of manures for an end which may be better attained by other means.

Sainfoin, when sown merely to produce one crop of hay, and then to be depastured for such a period as may be thought suited to the nature of the soil, answers well; but in this case, it is recommended that it be sown with a proportion of white clover and rye-grass. It is then merely a substitute for the red clover, and it is a good substitute, for it is a perennial, and will grow on soils on which the red clover cannot be profitably cultivated. It is in this way only, it is conceived, that the cultivation of sainfoin should be much extended in this country. It may be used as a substitute for red-clover, in many of the sandy, dry, and rocky soils of this country, which are intended to remain for several years in herbage.

Allied to sainfoin, is French Honeysuckle, *Hedysarum coronarium.* This is a perennial plant; but, when cultivated in this country, it becomes biennial. Its flower-stalks sustain spikes of rich scarlet flowers, sometimes white, which expand in June and July in the second year, and perfect their seeds in August or September, after which the roots decay.

This beautiful plant is a native of Italy, and other countries of the Mediterranean, where it grows in great luxuriance, affording excellent nourishment to horses, mules, and other animals. It is generally reckoned too delicate for field-culture in the north of Europe; but in our gardens it is seen to grow with surpassing beauty and luxuriance.

4. WILD SUCCORY, &c.

1. The Wild Succory, *Cichorium Intybus*, is a native of the British islands, as well as of many other countries. It is of the natural order *Compositæ.* It produces fine blue flowers, which open in the morning and shut in the evening. It is cultivated in many parts of Europe. In Lombardy, and other parts of Italy, it is sown with other herbs, and esteemed as increasing the milk and flesh of cattle. It is there regarded as nutritious when made into hay; and is used for feeding horses and other cattle by summer soiling. In France and different countries, it is produced extensively for forage and other purposes, and enters into the regular rotation of the fields. Succory is doubtless capable of being rendered useful as a forage plant. It is a native, and calculated to withstand the severest cold. It bears drought well, its large leaves covering the ground, and its roots striking deep into it. It grows with great quickness, comes very early in spring, and may be cut several times for forage in the year. If used for soiling, it will be ready in all cases before clover, and this would be a great benefit, as the means of carrying on a system of soiling.

Succory may be cultivated like clovers, and sown at the same time with corn in spring; but the mode of growth of the plant, which is like that of a lettuce, points out a different manner of cultivation, as more suitable to it. This is by cultivating it by itself, and in rows.

Under this system, the plant could be easily tilled by the horse and hand hoe. It can be sown at any period from March to September, and when above ground should be hoed out to the same distance in the rows as carrots, parsneps, and similar plants.

In the second year, it may be cut for forage as soon as it is ready in spring, and the mowing repeated throughout the year two or more times, as the crop is ready. Care must be taken that it do not shoot forth its flower-stems and run to seed.

When the seeds are sown broadcast, either with or without a corn-crop, the quantity may be from 12 to 14 lb. to the acre; but when it is sown in rows, a much smaller quantity will be sufficient.

The principal use of succory, as a field plant, is for green forage; though it may be also depastured. It is not well suited for being converted into hay, as is practised in Italy.

2. Oriental Bunias, *Bunias orientalis*, has been recommended for culture for its leaves. It is of the family *Cruciferæ*, of which some, as the cabbage and the rape, have been already described, as yielding abundant green forage. The oriental bunias differs from these in being a perennial. It grows freely after being cut, though not with so much luxuriance as the succory. It is a plant of a very wide range of temperature and situation, growing from Arabia Felix to Siberia.

3. Prickly Comfrey, *Symphytum asperrimum*, is of a natural family noted for its mucilaginous produce and emollient properties, namely, *Boragineæ*. It is a native of Caucasus. It is a perennial, is doubtless very productive, and is readily consumed by animals in a green state, and grows freely after being cut. It is one of many plants worthy of further experiment, as are likewise two native species, *Symphytum officinale*, Common Comfrey, and *Symphytum tuberosum*, Tuberous-rooted Comfrey.

4. To this mixed class of plants may be added *Ulex euro-*

pæus, Common Whin, Furze, or Gorse. This is a shrubby plant, of which the soft shoots are cropped by animals; but it does not form the subject of cultivation in this country, though in some places where the plant is produced naturally, its young shoots are cut off, bruised, and given to horses and other live-stock. It is exceedingly nutritive, and well relished by animals fed upon it, and, in the absence of cultivated forage plants, may be beneficially employed.

5. Clovers, Vetchlings, Melilots, &c.

Of the genus *Trifolium*, more than 160 species are enumerated by botanists, many of them deserving of the attention of cultivators. Those that are of most frequent cultivation for herbage and forage in this country are the Red and White Clovers.

Trifolium pratense, Red Clover, is a native species, and perennial, but the produce of that which is derived from France and other countries becomes, when cultivated in this country, biennial; though, by being prevented from running to seed, it frequently lasts to the third year or longer. As, however, in ordinary cases, it is only a biennial plant, that is, being sown in one year, and arriving at maturity and dying in the next, it is not well suited for permanent pasturage. But when the purpose is to keep the land one year only in forage or herbage, there is none of the species of trefoils which has been found equal to the red clover for largeness of return and early maturity.

Trifolium repens, Creeping White Clover, is a native species, hardy, perennial, and suited to a variety of soil and climate. No plant known in the agriculture of Europe is so generally capable of cultivation as the white clover. There are varieties of it more or less nutritive and productive. It is usually mixed with the last species in cultivation, and these again with one or more of the grasses.

Trifolium hybridum, Hybrid Clover, was so named by Linnæus from his supposing it to be intermediate between the two last species. It is a native of the south of Europe, but has been introduced into the agriculture of Sweden and the north of Germany. It seems to be well deserving of the attention of the agriculturists of this country, being of larger growth than the creeping white clover, and like it a perennial. It might, therefore, form a substitute for the red clover in cases where land is laid down to perennial herbage.

Trifolium minus, Lesser Yellow Trefoil, and *Trifolium procumbens*, Hop Trefoil, are frequently cultivated under the common name of yellow clover; and are, in practice, often confounded with the black medick already described. They are, however, both annual plants, and are not deserving of cultivation.

Trifolium medium, Zigzag Trefoil, is sometimes termed Cow-grass or Marl-grass. It is a native plant, perennial, and of easy culture. Its value, however, as a forage or herbage plant is not very satisfactorily determined.

Trifolium incarnatum, Crimson Clover, is a native of the southern and central parts of Europe. The colour of its flowers is a beautiful red. But it is an annual plant, and as it must be sown in autumn, that it may flower and arrive at maturity in the following season, it is not so well suited to the system of agriculture practised in this country as the red and white clovers. A variety of this species termed *Molineri*, with pale flesh-coloured flowers, is later in flowering than the crimson clover, but does not otherwise differ from it.

Trifolium alexandrinum, Egyptian Clover, is, like the last, an annual plant, and the same remark applies to it with regard to its suitableness for culture in this country. It is somewhat later than the crimson clover, but scarcely so productive of leaves.

It is not here necessary to enumerate other species of Trefoil. Those which experience has shown to be suited to this climate, and the modes of agriculture practised, are the red and creeping white clover.

Lathyrus, Vetchling or Everlasting Pea, contains about 60 species, of which 7 are native.

Lathyrus Aphaca, Yellow Vetchling, has been by some thought to merit attention as a forage plant from the luxuriance of its growth. Its seeds, however, are said to be deleterious, which we have seen is the case with another of the genus before described as cultivated for its seeds, *Lathyrus sativus*.

Lathyrus pratensis, Meadow Vetchling, is common in thickets, moist meadows, and even in good pastures. Although recommended for herbage by Linnæus, Haller, and others, it scarcely appears to merit a place amongst the cultivated herbage plants.

Lathyrus sylvestris, Narrow-leaved Everlasting Pea, is a perennial plant growing in moist meadows. It has a strong root, and grows with great luxuriance, intertwining with and overpowering the plants around it. How far it is grateful or nutritious to pasturing animals, has not been sufficiently determined.

Lathyrus latifolius, Broad-leaved Everlasting Pea, is a well-known climber, with peduncles bearing many gay flowers. It has been suggested by botanists that it might be applied to agricultural purposes. The plant is perennial, and would yield an abundant produce; but experiments are yet wanting to show how far, by its nutritive properties, it is calculated to become a useful forage plant. It has broader leaves than the last, but does not differ much from it in habit. The two, if grown together, would probably yield a large return of provender.

The other native species do not require especial notice. Numerous foreign species might be mentioned, as yielding a great produce in stems and leaves, but their uses for the purposes of the farmer have not been ascertained by experiment. Of the whole genus, it is to be observed that the characters are somewhat suspicious. The leaves and stems are often bitter, and some of their seeds, as those of *Aphaca* and *sativus*, slightly poisonous.

Melilotus officinalis, Common Yellow Melilot, King's Clover, or Hart's Clover, is a native species of easy culture, and though deemed annual, sometimes remains for more than one year in the ground. It is a tall plant, growing from 3 to 5 feet high and more, with a somewhat shrubby stem. It has a certain bitterness of taste, and a smell similar to that of sweet-scented vernal grass; yet it does not appear to be disliked by animals, and might be cultivated in certain cases for forage.

Melilotus leucantha, White-flowered Melilot, is likewise a native species, and of habits and character similar to the last, though often growing much taller.

Melilotus macrorhiza, Long-rooted Melilot, is a native of Hungary, and is cultivated in some parts of Europe. It is a perennial plant, and might yield a considerable supply of green forage or herbage on certain sandy soils.

Lotus corniculatus, Common Bird's-foot Trefoil, is an abundant plant in the higher natural pastures of this country. It is perennial, and in the month of June is readily distinguished by its tufts of yellow flowers. It is a small plant in its natural habitat, but enlarges by cultivation.

Lotus major, Greater Bird's-foot Trefoil, is by some regarded merely as a variety of the last species; but its characters are distinct, and continue so when cultivated under circumstances precisely similar. Both these species, and especially the latter, merit attention as herbage plants.

Common Broom can hardly be mentioned as a leguminous herbage-plant, though its young shoots are eaten by stock; but, when old, they are too bitter to be used. One of the genus, however, *Cytisus albus*, Spanish Broom, is used in the south of Europe as food for sheep.

6. Heaths, Sedges, and Rushes.

These may be said to constitute a class of herbage-plants; they are generally of very inferior nutritive properties, but, forming a large part of the unimproved pastures of the country, they are of interest to the agriculturist.

The Heaths, *Ericeæ*, cover a very large proportion of the high lands of this island, and are frequently found extending to the plains. They indicate very generally the existence of peaty matter in the soil.

Of the native species, the most abundant is *Calluna vulgaris*, Common Heath or Ling, which extends over all the primary and transition districts of this country. It is a bushy shrub, growing from half a foot to 4 feet in height. The branches of it afford shelter, and its seeds food, to numerous birds of the grouse kind. Bees collect honey largely from its flowers, and the honey is of a dark colour, and by many esteemed beyond that derived from the lower plains. Almost every part of the north of Europe abounds with this plant. It is used in some parts as dried fodder for cattle, and as thatch for covering houses and cabins. It is formed into ropes and other things for which straw is used: a decoction of it is employed for the purposes of tanning; a yellow colour is extracted from it for dyeing wool: and a species of ale can be made from its young shoots, mixed with a proportion of malt. In conjunction with the dried turf in which it grows, it is used in many places as fuel, though it is not so well suited for this purpose as the thicker strata of peat.

Sheep, goats, and cattle will feed on the young shoots of this and other species; but they prefer the gramineous plants. In order to cause the young shoots to spring, it is a common practice to set fire to the heath. This should be done in regular divisions over a stock farm, so that successive portions of young heath shall be obtained for the pasturing stock. By regular burning and close pasturing with sheep, the heath becomes less in quantity, and the grasses supply its place. The process is slow, but often it is the only practicable mode of improving mountain heaths.

The *Cyperaceæ*, or Sedge tribe, contain numerous species, which often so nearly resemble the grasses in appearance that they may be confounded. They are found in marshes, ditches, and running water. They are found also in heaths moist woods, and meadows; and certain species on sands, and on the sea-shore. They are a far inferior class to the grasses in their nutritive properties; for, while the grasses are noted for the abundance of sugar and fecula which they contain, the sedges are remarkable for the absence of these principles. They are frequently mingled with the grasses, and form a part of the sward of our natural meadows, and sometimes they intrude amongst our cultivated herbage-plants, when they are to be regarded as weeds. Sometimes, however, the plants of the sedge-family are important, from their covering large tracts of country, and affording an abundant coarse herbage. Thus, the Scaly-stalked Spike-rush, *Eleocharis cæspitosa*, grows on certain moors and moist heathy places in great profusion. In the Highlands of Scotland it is called Deer's-hair, and occupying extensive tracts almost exclusively, is valued on account of its spring and summer pasturage.

The cotton grasses, too, *Eriophora*, are common in bogs, and send forth leaves very early in spring. They thus afford an early herbage in high countries for live-stock.

The *Junceæ*, or Rush-family, occur largely in the moister pasture-lands of this country. These plants are the most common indicators amongst us of wetness in the soil. They are all of an inferior class as herbage-plants, though they are cropped by cattle in their young state, and in the higher districts are frequently converted into hay.

The most common species in low wet meadows are, *Juncus conglomeratus*, Common Rush, and *Juncus effusus*, Soft Rush. They are best got rid of by removing from the soil the wetness, whether of the surface or substratum, by draining.

A very frequent species in the elevated parts of this country is *Juncus acutiflorus*, Sharp-flowered Jointed-rush. This species is very common in peaty bogs, forming often the greater part of their herbage. It is familiarly known under the name of sprit or sprat. Though animals do not eat it readily, unless in the absence of better food, yet, being made into hay, it is eaten largely by the hardier kinds of cattle.

7. GRASSES.

The most important of the herbage-plants of this and other parts of Europe are the grasses. Of these, however, many are of low nutritive and productive powers, and in cultivated grounds are held to be weeds. But some of the less valuable kinds require attention on account of their frequent occurrence, and their adaptation to soils low in the scale of fertility.

1. *Anthoxanthum odoratum*, Sweet-scented Vernal-grass. This is one of the earliest grasses of the spring, coming into flower about the middle of April, and ripening its seeds by the middle of June. It contributes mainly to give that delightful fragrance to new-mown hay, so familiar to us. It grows on almost every soil; it is not of itself remarkable for its nutritive qualities. nor does it seem to be peculiarly grateful to cattle, although eaten by them along with their other herbage. Its value is chiefly derived from its early growth, its hardiness, and its property of continuing till late in autumn to throw forth its flowering stems. It can scarcely form the subject, in any case, of useful cultivation.

2. *Alopecurus pratensis*, Meadow Fox-tail. This is a very generally diffused species, being a native of Britain and of most parts of Europe. Its herbage is held to be nutritive, and it appears to be grateful to ruminating animals. It is a very early grass, is perennial, and constitutes a considerable part of the richest of our meadows. It does not attain its full growth for several years, on which account it is not well suited to the alternate husbandry. The young plants, too, are so frequently the prey of insects, and the seeds are often so defective, that only an inconsiderable portion of them can be calculated on arriving at maturity. Notwithstanding of these things, this plant, on account of its early growth, its permanence in the soil, and the quantity and value of its produce, deserves to be cultivated when the land is intended for perennial herbage.

3. *Phleum pratense*, Meadow Cat's-tail. This species is a native of Britain, though it was first introduced into notice from Carolina. It is called herd-grass in America, and is greatly valued there as an herbage and forage plant. It produces abundance of foliage early in spring, and may be cropped till a late season. There is none of the grasses more easily cultivated. It is not a peculiarly good hay-grass, from the wiryness of its stem, and the shortness of its aftermath. But still it may be profitably cultivated for this purpose in conjunction with other grasses, and deserves to be cultivated in an especial manner when the purpose is to produce a sward of permanent herbage, or even when the land is to remain only one year in grass.

4. *Agrostis alba*, Marsh Bent-grass, is one of the species of *Agrostis* which grow on moist soils, and which, having generally creeping roots or stolons, form frequently troublesome weeds. It sometimes passes under the name of Black Couch-grass. When it takes possession of wet clayey soils, its roots penetrate to a considerable depth, and from their vivacious properties, it is very difficult to extirpate them. In more favourable circumstances, the marsh bent-grass grows with broader leaves, and assumes the appearance of one of the superior grasses. It was under this form that it was introduced to notice as a beneficial object of cultivation under the name of Fiorin Grass. It grows naturally in the moister soils, and extends itself sometimes to the extirpation of less powerful grasses, by its creeping roots and stolons. Its best property as a pasture grass is the late period at which it rises in the season, affording food when other grasses have ceased to grow, and in spring also it affords an early herbage. These properties may render it sometimes expedient to cultivate this plant in small quantity, mixed with other grasses, when the end is perennial herbage, and especially in the case of irrigated meadows; but otherwise it does not possess properties to entitle it to be ranked amongst the superior grasses.

5. *Holcus lanatus*, Meadow or Woolly Soft-grass, grows readily upon all soils, and especially the peaty. It produces a

profusion of light seeds, which are easily dispersed by the wind; from which circumstance, when it is once introduced, the soil is with some difficulty freed from it. It is disliked by cattle, and refused by them when other herbage can be obtained. Nevertheless, the woolly soft-grass is not without its useful properties. It is superior to the heaths and some of the bents of peaty lands. Its easy propagation, therefore, on such soils is in this respect beneficial, that a pasture-grass can be substituted for the inferior natural produce of the soil. Although the woolly soft-grass may therefore be sown on the poorer class of peaty soils, it ought to be excluded from those on which better kinds can be produced.

6 *Holcus mollis*, Creeping Soft-grass is frequently mistaken for the woolly soft-grass, but is readily distinguished from it by its awned florets and creeping root. The herbage of this plant is soft and tasteless, and apparently more disliked by stock than that of the woolly soft-grass. It is a troublesome and empoverishing weed, which it should be the study of the husbandman in every case to extirpate.

7. *Arrhenatherum avenaceum*, Common Oat-like grass, is the *Avena elatior* of Linnæus, and the *Holcus avenaceus* of some other botanists. It is a coarse though a productive grass, growing rapidly after being cropped, and producing an early and plentiful herbage in spring. It has been found upon analysis to contain more of bitter and saline matter than other pasture grasses, and hence it has been inferred that it ought not to be cultivated without a large admixture of other grasses. The juster inference would be that it should not be cultivated at all. The roots, which are fibrous in the moister soils, become bulbous in the drier, and then the plant is a troublesome weed, difficult to be extirpated.

8. *Poa aquatica*, Reed Meadow-grass. This species grows in situations favourable to it to a great height. It is common in flat and fenny countries, on the banks of rivers and the margins of pools. In the fens of Cambridge and Lincoln great tracts are covered with this grass, which not only affords rich herbage in summer, but abundant crops of hay for winter

forage. It contains a larger proportion of sugar than the best herbage grasses, and is accordingly much relished by pasturing animals. It is, however, too purely aquatic in its habits to allow of any extension of its culture. It is well suited to the swamps and fens where it grows naturally, but can scarcely be cultivated beyond them.

9. *Poa fluitans*, Floating Meadow-grass. This plant is found in ditches, stagnant waters, and other moist situations, its stem growing from 1 to 3 feet high. Its seeds are the manna of the shops, and are gathered abundantly in Poland, Russia, and some parts of Germany, where they are used as food. It is found in New Holland, a country abounding in vast marshes. It has been thought by some that it might be cultivated in this country. It is to be believed, however, that it is rather too aquatic in its habits to admit of cultivation, except in cases where it could be partially covered with water.

10. *Poa annua*, Annual Meadow-grass. This species has an annual root. It continues to flower throughout the spring, summer, and autumn, and sometimes even in winter. It rarely attains, even in the most fertile situations, a height of more than 10 or 12 inches. It is, however, the most prolific of all the grasses. The only case in which we can suppose this species deserving of cultivation, is when other grasses had died out; and when, by being sown on the sward of these grasses in spring or autumn, the annual meadow-grass might be expected to afford a growth of herbage in a few months.

11. *Poa trivialis*, Rough-stalked Meadow-grass, is one of the superior pasture grasses, forming a part of our richest meadows. Its root is fibrous, and its stems are roughish, and hence its name. Rough-stalked meadow-grass is nutritive, and greatly relished by pasturing animals. It requires, however, situations somewhat sheltered and moist. In dry and exposed ground its produce is inconsiderable; and this circumstance must determine, in certain cases, the expediency of cultivating it.

12. *Poa pratensis*, Smooth-stalked Meadow-grass. This species is distinguished from the last by its having a creeping

root, and by the sheaths of the stem being smooth to the touch. It comes early, but, in this respect, is equalled by other grasses believed to be more productive, and after being cropped in summer it grows slowly. It is inferior to the last-mentioned species, and it may be questioned whether it deserves to be reckoned amongst the superior pasture grasses.

13. *Poa fertilis*, Fertile Meadow-grass, is a native of Germany, where it is esteemed one of the superior pasture grasses. It grows in wet situations, and near rivers. It is said to perfect its seeds abundantly. Experiments, however, are yet wanting, in this country, on the value and uses of this species.

14. *Dactylis glomerata*, Rough Cocksfoot. This is a coarse but very nutritive grass, of early and rapid growth. Although a native of Britain, its seeds were introduced from Virginia about the year 1780. It was not, however, cultivated till many years afterwards. It is justly held to be amongst the superior pasture grasses, and is suited for forage as well as for herbage. It is more nourishing in spring than in autumn, and requires to be closely cropped: for, when suffered to grow, it rises in tufts and patches, and loses greatly of its nutritive properties. Oxen, horses, and sheep, eat this grass eagerly. Cocksfoot should always be sown in combination with other grasses, as the rye-grass, the meadow-fescue, and the other finer grasses.

15. *Cynosurus cristatus*, Crested Dog's-tail, has a wide range of soils and situations, and is plentifully produced in most of our natural pastures. It flowers somewhat late, and its culms, when it perfects its seeds, become hard and wiry, and are rejected by pasturing stock. Although slow in arriving at perfection, late in flowering, and not very productive, this grass, on account of its easy culture, and the thick sward which it tends to produce, has been recommended for cultivation. This, however, should only be on inferior sheep pastures, for the plant is not to be regarded as one of the superior grasses.

16. *Festuca ovina*, Sheep's Fescue-grass, is one of the smaller grasses growing on dry light elevated grounds. It is entirely an herbage plant, and is only referred to here be-

cause botanists have spoken of it with approbation. It is a grass, however, which there can be no object in cultivating in arable soils in this country. The business of the farmer is to stock his pastures with the best grasses which they are capable of producing: inferior kinds will quickly tend to occupy the ground.

17. *Festuca duriuscula*, Hard Fescue-grass, is likewise one f the small grasses suited to the pasturage of sheep. It preails on the lighter soils, but is found also in good natural pastures. It is superior in size to sheep's fescue; but yet it s not sufficiently productive to deserve especial cultivation.

18. *Festuca loliacea*, Spiked Fescue-grass, grows in moist meadows, and is said to be very productive; but experiments are yet wanting on its value as an agricultural plant. It rarely with us perfects its seeds; which, however, would not be an objection to its cultivation were it otherwise useful, since seeds, in sufficient quantity, might be obtained from other countries.

19. *Festuca pratensis*, Meadow Fescue-grass, is justly ranked amongst the superior grasses. Although a large it is not a coarse plant, and does not, like some of the other larger grasses, form tufts in growing. The leaves are succulent, and readily eaten by the larger pasturing animals. Its root is perennial and fibrous. It is found in the natural meadows of our richer clay-land vales, and may form a part of the pasture of all land of tolerable quality, laid down to perennial herbage. It requires, however, a longer time to arrive at its full maturity than some others of the superior pasture grasses, as the cocksfoot, and is, therefore, less suited than they to the alternate tillage.

20. *Lolium perenne*, Perennial Darnel or Rye-grass, is one of the most important of the gramineous herbage plants. It is the most generally cultivated of the herbage-grasses in Europe. This circumstance it owes to its early maturity, to its wide range of temperature and soils, and to the abundance and facility with which it can be raised from its seeds.

However valuable the rye-grass from these qualities be, it wants certain properties which others of the grasses possess, and a good permanent meadow, therefore, will best be procured by imitating the natural process of mixing grasses together. In this manner, the different kinds coming into flower at different periods of the year, will better afford a succession of herbage throughout the season.

The characters of this plant are greatly modified by the effects of climate, soil, and culture, and this has given rise to numerous distinctions, founded on the supposed qualities of the different sorts. The value of these to the agriculturist is mainly determined by the number and broadness of their leaves, their permanence in the soil, and the vigour with which they grow.

There are two kinds, however, which must be distinguished from each other in practice. The one flowers for successive years, and is therefore termed perennial; the other flowers in the second year, and, having borne its flowers, the root decays. This is, therefore, a biennial plant, but it is generally termed annual rye-grass It is more productive than the perennial kind in the year after being sown, and hence, when the purpose is to retain the land only one year for a crop of herbage or forage, the shorter-lived variety is to be preferred. There are no means of distinguishing the biennial from the perennial kinds by their seeds alone, and great losses have been frequently sustained by mistaking the one for the other, when the purpose has been to keep the land for several years in grass. When the land is to remain for more than one year in grass, the perennial kinds must be sown.

Rye-grass should always be sown with some of the clovers. Mixed with the red clover, as will be afterwards seen, it is well suited for hay. No other mode has yet been discovered equal to this for producing a crop of hay with certainty and economy, as the experience of farmers in the north of England, in Scotland, Flanders, and other parts of Europe, testifies.

21. *Lolium Italicum*, Italian Rye-Grass, is cultivated in Italy, and other parts of Europe. It is probably in most cases

of biennial duration, but by being cropped or mown before flowering, it may remain for several years in the ground. It reproduces itself freely from its seeds, which are scattered immediately on their becoming ripe. It grows with greater luxuriance than the common rye-grass, and its nutritive properties may be inferred from the eagerness with which it is eaten by animals. It appears to be a very valuable herbage-plant; but farther experiments are yet required to show how far its permanence in the ground can be depended on.

It thus appears, that the native grasses which experience has fully shown to be of the superior class, and suited to cultivation, are :—

1. Alopecurus pratensis—Meadow Foxtail.
2. Phleum pratense—Meadow Cat's-tail.
3. Festuca pratensis—Meadow Fescue.
4. Poa trivialis—Rough-stalked Meadow-grass.
5. Dactylis glomerata—Rough Cock's-foot.
6. Lolium perenne—Rye-grass.

To which may now be added,—

7. Lolium italicum—Italian Rye-grass.

8. Burnet, &c.

Burnet, *Poterium Sanguisorba,* has been frequently recommended, and partially cultivated, as an herbage-plant. It is of the Rose family. It grows naturally on dry and calcareous soils, with a stem of about a foot or more in height. It is a very hardy perennial, remaining verdant during the winter, and yielding an early spring food. It is this that constitutes the sole value of burnet on the inferior class of calcareous soils on which it grows, for in weight of produce and nutritive properties it cannot be compared with the clovers, and other leguminous herbage-plants.

The Corn Spurrey, *Spergula arvensis,* is cultivated in some countries for herbage. It is of the Pink tribe of Plants, and is a native of the Old and New Continents, growing about

Quebec, and the river Columbia, and plentifully in the gardens and fields throughout Europe. It is termed Spergula, or Spergularia, from the property which it possesses of spreading its seeds. It is by all foreign writers extolled as being very nutritious, and giving a rich flavour to butter. It is valued for its rapid growth. Being sown on the stubble in autumn, it will produce a crop in the same season. It is with us, however, regarded as a weed, and, from the smallness of its produce, can be of no value as an herbage plant under the system of agriculture pursued in this country.

The Yarrow, *Achillea Millefolium*, of the natural family *Compositæ*, is a plant which is found in our richer meadows, and is closely eaten by pasturing animals. The yarrow has, on this account, been cultivated along with other herbage-plants, though with what precise benefit has not been well determined.

Ribwort Plantain, *Plantago lanceolata*, has been extensively cultivated in this country as an herbage-plant, under the name of Rib-grass. It is easily raised, and is eaten in its young state by pasturing stock: but no experiment has yet shown that it ought to take the place of gramineous and leguminous plants of known value.

Of the various plants which have been enumerated, some are chiefly adapted to forage, some to herbage, and others may be employed partly for forage and partly for herbage. Several of the forage-plants, from their habits of growth, are best cultivated by themselves, or with a very slight intermixture of stranger plants. Of this kind are the tare and other vetches which are mown for forage; lucerne, sainfoin, when used for forage; wild succory, and others. The trefoils, again, and the other smaller leguminous herbage-plants, are best mixed with some of the grasses; and it is a point of useful practice, to determine what kinds should be selected, and in what proportions they should be mixed.

The most frequently employed of the leguminous plants for mixed forage and herbage are the red and white clovers, and of the indigenous grasses, rye-grass. This grass is well suited for general culture, arriving more quickly than most of the others at maturity, producing abundance of seeds, at all times easy to be obtained, and growing well under the shade of corn. For whatever period, then, land is to remain in grass after being sown, it will generally be well to sow such a quantity of the seeds of the rye-grass as will produce a crop of that grass alone, independently of the other grasses which may be mixed with it.

If the land is to remain for only one year in grass, then the rye-grass alone will be sufficient to form with the clovers good forage and herbage; yet it will add to the value of the produce even for a single year, to sow with it a small proportion of the seeds of any of the indigenous grasses; and of these, the best for this especial purpose is the meadow cat's-tail, because it is the most easily propagated, and arrives the soonest at maturity.

There may be sown 20 lb. of these two grasses in all, and 10 lb. of red and white clover, of which four-fifths may be red clover. The proportions may be—

Rye-Grass, ...	17 lb.	
Meadow Cat's-tail, . . .	3	
		— 20 lb.
Red Clover, ...	8	
White Clover, . . .	2	
		— 10
		30 lb.

A mixture in these proportions will yield a good produce for one season, whether it is used as herbage or forage.

But if the land is to remain for more than one year in grass, then a mixture may be made of such of the other superior grasses as can be procured; while the quantity of the red clover may be diminished, and some other of the leguminous herbage plants mixed with the clovers. We may sow in this case 12 lb. of the rye-grass seeds, which in most cases will be sufficient to secure a crop of this plant alone; and we may sow the other grasses in such quantity that the whole shall amount to 24 lb. The following may be the proportions:

Meadow Fox-tail,	3¾ lb.	
Meadow Cat's-tail,	½	
Rough Cock's-foot,	5	
Meadow Fescue,	2	
Rough-stalked Meadow-grass,	¾	
Rye-grass,	12	
		— 24 lb.

To which are to be added:

Red Clover,	2	
White Clover,	6	
Bush Vetch, Tufted Vetch, or other perennial leguminous herbage plants,	2	
		— 10
		34 lb.

In the preceding mixture of grasses, the quantity of rye-grass is equal to about half a bushel; and with regard to the other grasses, the proportions are such that each will, in ordinary circumstances, produce an equal number of plants. These proportions are obtained by computing the number of seeds in a given weight, and the number of each which, on an average, is found to vegetate.

Were it wished that the rye-grass should be merely in proportion with the other grasses, and that each kind should produce an equal number of plants, the following would be nearly the proportions:

Meadow Fox-tail,	5¾ lb.
Meadow Cat's-tail,	1
Rough Cock's-foot,	7¾
Meadow Fescue,	3
Rough-stalked Meadow-grass,	1¼
Rye-grass.	5¼
	24 lb.

VIII. WEEDS OF AGRICULTURE.

The plants which have been described are those which form the subject of especial cultivation. The weeds of agriculture are those which grow amongst the cultivated plants, and which it is the province of the farmer to destroy. The prevailing plants of this class vary in every country, and in different parts of the same country.

Weeds may be divided into two general classes; those which propagate themselves solely by their seeds, and which, having once flowered, perish; and those which have perennial roots, and flower and bear seeds for successive years. The first are annual or biennial plants, according as they require one or two years to complete the period of their vegetation. The second are perennial plants, and grow again from the roots, as well as propagate themselves from their seeds.

In the case of annual or biennial weeds, if the stem is destroyed at the time of flowering, or just before it, the individual is destroyed, and its further means to propagate the species are taken away; but in the case of perennial weeds, the destruction of the stem does not infer the destruction of the plant, because the plant has the power of propagation from the roots. From this distinction, it would seem more easy to destroy annual than perennial weeds, yet this conclusion does not always hold; for some of the annual species have such numerous minute seeds, that it is often very difficult to extirpate them, and when they have got into ground, keep possession even more inveterately than those which have the power of springing again from their roots.

Of the perennial weeds, greatly the most troublesome are those which have creeping roots; for these extend themselves below ground, and if any of the parts of the roots remain, these may give birth to new plants.

Either class of weeds may be frequently destroyed by the same means, namely, by assiduous tillage of the ground; but yet a natural division of them is into such as have annual and biennial roots, and such as have perennial roots.

1. ANNUAL AND BIENNIAL WEEDS.

Of weeds which have annual or biennial roots, the following are the most prevalent in this country.

1. Sinapis arvensis—Wild Mustard.
2. Raphanus Raphanistrum—Wild Radish.
3. Papaver Rhœas—Corn Poppy.
4. Centaurea Cyanus—Corn Blue-Bottle.
5. Chrysanthemum segetum—Corn Marigold.
6. Pyrethrum inodorum—Corn Feverfew.
7. Sonchus oleraceus—Sow-Thistle.
8. Cnicus lanceolatus—Spear Plume-thistle.
9. Arctium Lappa—Burdock.
10. Agrostemma Githago—Corn Cockle.
11. Stellaria media—Common Chickweed.
12. Spergula arvensis—Corn Spurrey.
13. Galium Aparine—Goose-grass.
14. Urtica urens—Small Nettle.
15. Lamium purpureum—Red Dead-Nettle.
16. Galeopsis Tetrahit—Common Hemp-Nettle.
17. Euphorbia helioscopia—Sun-Spurge.
18. Polygonum convolvulus—Climbing Buckwheat.
19. Polygonum aviculare—Knot-grass.
20. Ervum hirsutum—Hairy Tare.
21. Lolium temulentum—Bearded Darnel.
22. Avena fatua—Bearded Wild Oat.
23. Bromus mollis—Soft Brome-grass.

1. The Wild Mustard, the Charlock of farmers, frequently springs up in vast abundance in fields of growing corn. It flowers in May or June, and as it ripens and sheds its seeds before harvest, it is difficult to extirpate it. Sometimes its flowers are cut off by a scythe or hook as they rise above the corn in spring; and sometimes they are pulled up from amongst the corn by the hand, which is an unsatisfactory and operose me-

thod. The row culture is, in an especial degree, beneficial in the case of this and similar plants, for the first crops of them can be cut down by the hoe in spring. But the period most suitable for destroying the wild mustard is during the summer-fallow and fallow-crops. Yet under any circumstances it is difficult to subdue it, its seeds lying for an indefinite period in the soil, until brought by the plough within the influence of the air. Often it springs up without any known cause, and covers entire fields. It abounds in fields of turnips, contending for mastery with the young plants. Other species of sinapis also spring up in cultivated ground, but this is the most prevalent and hurtful.

2. The Wild Radish, or Jointed Charlock, like the wild mustard, has yellow flowers, and grows and sheds its seeds amongst corn. The two plants, from their similarity, are frequently confounded together, and pass under the common name of charlock.

3. The Corn Poppy is distinguished in summer by its gay red flowers. It sometimes rises in large quantities in corn-fields, especially in soils that are dry, sandy, or gravelly. It receives the name of red poppy, corn-rose, red-weed, &c.

4. The Corn Blue-Bottle is of a genus which contains several species known as weeds. That, however, which is peculiar to corn-fields is the corn blue-bottle. It grows amongst corn, but rarely in great quantity, and its presence merely indicates careless farming.

5. The Corn Marigold is of a genus that supplies our gardens and greenhouses with many beautiful flowers. From the colour of its flowers it is in some places termed yellow bottle, in other places gowlands, or yellow gowans. It grows amongst fields of corn, and may be pulled by the hand. It is not in this country a very generally diffused weed, being found only in particular parts. But in some sandy districts of Europe it prevails to so great a degree as to destroy the crops.

6. The Corn Feverfew or Scentless Mayweed, is generally classed by farmers, under the name of Mayweed, with two other plants of similar appearance, Stinking Chamomile and Wild

Chamomile. The corn feverfew rises sometimes in cultivated land in considerable quantities.

The corn poppy, the corn blue-bottle, the corn marigold, and the different mayweeds, may be said to form a class. They grow up with the crops of corn, and announce by their beautiful flowers the return of the warmer season. They are not of the formidable class of weeds, and yet assiduous tillage is required to eradicate them. They are frequently conveyed to the farm with the seeds of corn, and then careful winnowing is the best preventive.

7. The Sow-thistle grows in fields of corn. It is of a family of plants whose light seeds are widely dispersed by the winds. But although a common, it is not a dangerous weed.

8. Spear Plume-thistle is one of a genus of troublesome weeds, but which are mostly perennial, while the spear plume-thistle is biennial. It sometimes abounds in old pastures. It may in all cases be destroyed by cutting it over when in flower, and before its seeds are ripe.

9. The Burdock is a familiar plant, whose hooked scales fasten themselves pertinaciously to clothes and the fur of animals. It is a biennial plant, seldom injurious, and easy to be extirpated.

10. The Corn-Cockle or Corn-Campion, is of the pink tribe of plants. The flour of its seeds mixed with grain injures greatly the quality. The seeds are heavy, and, on this account, cannot be separated from corn in the operation of winnowing. It grows singly, chiefly amongst wheat; and being easily distinguished, it can be pulled up by the hand.

11. Common Chickweed is of the same natural family, but of a different habit of growth. It grows not alone, but thickly in the parts of fields which are enriched by the dung of animals. Under careless management it is often a troublesome weed; and, in fields of turnips, it will contend for mastery with the young plants.

12. Corn Spurrey, likewise of the Pink tribe, sometimes grows thickly in corn-fields, and then it indicates bad condition of the soil, or careless farming.

13. Goose-grass, called also cleavers, catchweed, and goose-tongue, grows naturally in hedges, but is carried also to the cultivated fields, where it propagates itself rapidly. Its seeds are furnished with hooked bristles, which attach themselves to the fur of animals, and in this manner are disseminated. In some parts of England it is a troublesome weed, but in other parts it is comparatively inoffensive.

14. The small Nettle is an annual plant. It sometimes extends over cultivated fields, and generally indicates that the soil is enriched by putrescent substances.

15. The Red Dead-nettle, though termed a nettle, is of the Mint tribe of plants. It is thus of the same family as the mint, the marjoram, the sage, and the thyme, plants all harmless, and possessing cordial and stomachic properties. The red dead-nettle is sometimes frequent in fields, especially near hedges, and in sheltered places.

16. The Common Hemp-nettle, also of the Mint tribe of plants, is common in corn-fields. Reapers are sometimes affected by severe inflammation in the hand by grasping it. It is covered by bristles, and these, on being pressed, emit a poisonous fluid.

17. Sun-Spurge is one of a family of plants which yield a peculiar milky juice. It is sometimes abundant in corn and turnip fields.

18. Climbing Buckwheat, is in some places termed bindweed, or bearbind. When in quantity it is apt to overpower the corn. It is frequently seen twining round turnips and other plants. Its seeds are said to injure wheat; but the seeds are in themselves nutritive, and, if mixed with oats, will not injure their quality.

19. Knot-grass is another of the buckwheat genus, of frequent occurrence; but it abounds more in waste places than in cultivated grounds.

20. Hairy Tare is a leguminous plant which frequently occurs in cultivated fields, and then it is a hurtful weed.

Several of the annual grasses are of frequent occurrence in cultivated grounds.

21. The Bearded Darnel is common in some countries, but it is comparatively rare in this. It has been condemned as a poisonous plant for more than 2000 years.

22. The Bearded Wild Oat is often a very pernicious weed. Its seeds readily drop out when ripe; and as it ripens sooner than the cereal grasses, and then sheds its seeds, it is difficult to extirpate it. It is frequently conveyed with the seed-corn to the ground, and thus may be propagated on the best managed farms.

23. Several of the Brome-grasses are found as weeds in our corn-fields. The most frequent of these is the Soft Brome-grass, in some places termed goose-grass. The seeds of this plant are like those of rye-grass, and are propagated along with that grass. But the plant itself is easily distinguished from the rye-grass; and when the latter is to be thrashed for seeds, the Brome-grass may be picked out by the hand.

The list of this class of weeds might be greatly extended, but this does not seem to be here necessary. They are all of them best extirpated by diligent tillage. The better cultivated a country becomes, the less prevalent and hurtful will be this class of plants.

2. PERENNIAL WEEDS.

1. Ranunculus acris—Upright Meadow Crowfoot, and other Ranunculi.
2. Senecio Jacobea—Common Ragwort.
3. Tussilago Farfara—Coltsfoot.
4. Bellis perennis—Daisy.
5. Chrysanthemum Leucanthemum—Great White Ox-eye.
6. Cnicus arvensis—Corn or Way-thistle.
7. Centaurea nigra—Black knapweed.
8. Sonchus arvensis—Corn Sow-thistle.
9. Lamium album—White Dead-nettle.
10. Rumex obtusifolius—Broad-leaved Dock.
11. Polygonum amphibium—Amphibious Persicaria.
12. Urtica dioica—Great Nettle.
13. Agrostis alba—Marsh Bent-grass.
14. Arrhenatherum avenaceum—Common Oat-like Grass.

15. Holcus mollis—Creeping Soft Grass.
16. Triticum repens—Common Wheat-grass.
17. Juncus effusus—Soft Rush, and other Junci.
18. Ericæ—Heaths, and other shrubby plants.
19. Filices—Ferns.
20. Musci—Mosses.

1. The Upright Meadow Crowfoot grows in a great variety of soils and situations. Like most of the dangerous family to which it belongs, it inflames and blisters the skin. It is too acrid to be eaten by cattle, unless largely mixed with other plants; but so mixed, it is consumed in small quantity, and, from its abounding in our meadows, is perhaps designed to serve as a condiment. In common with some others of the genus, it is termed butter-cup, or butter-flower, from a popular notion that it gives the yellow colour to butter. It, however, injures the butter, whose yellow colour is due to the richness of the pastures, and not to these acrimonious plants.

The Creeping Crowfoot, *Ranunculus repens*, and Bulbous Crowfoot, *Ranunculus bulbosus*, resemble the last in their properties. They adorn our meadows with their bright yellow flowers, and are comprehended under the common name of butter-flower, butter-cup, and sometimes of king's-cup, golden-flower, &c. The breaking up of grass land for a course of tillage is the only means of eradicating this class of weeds.

2. Common Ragwort is a large well-known weed in pasture fields. It receives many names, as ragwort, ragweed, canker-weed, &c. It has a perennial root, and grows to the height of 2 or 3 feet. It is best kept down by pasturing with sheep, which eat it in its early stages. By being pulled up by the hand, which can be easily done when the ground is soft from rain, it can be extirpated in grass fields without taking up the land for a course of tillage.

3. Coltsfoot grows chiefly in moist clays, and especially in marly soils. Its broad leaves overspreading the surface, it is very hurtful where it prevails. Tillage and draining, and improving the texture and fertility of the soil, are the means to be adopted for rooting it out.

4. The Daisy, though every-where loved and admired as the harbinger of summer, and the ornament of our fields, is, in the judgment of the farmer, a weed. Where it prevails too greatly, the land requires to be renovated by a course of good tillage, and by lime.

5. The great White Ox-eye, sometimes also called the great white daisy or moon-flower, often abounds in pastures, and is only to be extirpated by tillage.

6. Thistles form a class of weeds very formidable to the agriculturist, from the ease with which they are disseminated by means of their downy seeds, and the difficulty of eradicating them. Some of them have deep vivacious roots, and all of them, on account of their vigorous growth, and their strong spreading leaves, are injurious amongst the cultivated plants.

The most common of the thistle kind is the corn or way-thistle. This plant has strong, creeping, and vivacious roots, the habit of which is to strike down to a great depth in the ground. If any parts of these roots are left in the soil, they will again give birth to numerous plants.

The means of extirpating the way-thistle from land is by a continued tillage and deep ploughing. Even an efficient year's summer fallow will not always effect this; for when land has been thoroughly overrun by the plants, they will spring up in future years, and require successive years' tillage thoroughly to exterminate them. The lands of various parts of this country used to be greatly more covered with thistles than they now are. In some parts of Scotland, they were once so abundant, that they used to be cut regularly for five or six weeks in summer to supply food for the wretched cattle of the day. In well-cultivated districts they have been got under, though, so great is their tenacity of life and power of propagating, that they demand constant attention on the best cultivated farms, and, under negligent management, never fail to take possession of the soil. New lands brought into cultivation are often entirely covered with this species, and a course of tillage is necessary before it can be subdued.

In the ordinary management of a farm, thistles will sometimes spring up in great abundance with the first crop of oats after grass. In this case, they must be weeded early in summer, by being cut over near the surface, which is conveniently done by the weed-hook (Fig. 123). The sole effect of this, however, is to retard the growth of the plant, and prevent it from running to seed, or contending for mastery with the growing corn.

Thistles sometimes spring up in great plenty in old pasture fields. In this case, they should be cut close to the ground at least once a-year, so as to prevent their smothering the pasture plants and running to seed. But it is only when the land is broken up for tillage that effectual means can be used for destroying them. Instruments indeed, have been devised for pulling up thistles from the ground, but the roots of the plant are too easily broken, and the smallest portion left in the soil will spring again.

The thistle not only grows from its creeping vivacious roots, but is widely disseminated by its light downy seeds. Thistles therefore ought to be cut down before being permitted to perfect their seeds; and they should never be suffered to grow in waste places and hedges, whence their light seeds may be carried to poison the neighbouring fields. Further, when they have been cut down at an advanced stage, they should not be left on the ground, for, like many compositæ, they will mature their seeds though separated from the ground.

7. Black Knapweed is one of a class of thistle-like plants. It is termed horse-knot, and receives many other local names. It is a hurtful weed in pastures where it prevails, increasing much by the roots, and being extirpated with difficulty.

8. The Corn Sow-thistle is a frequent plant in corn-fields, distinguished by its tall stems and large yellow flowers: but it is not usually a very hurtful weed.

9. The White Dead-nettle is occasionally common in corn-fields. Having a strong, creeping, perennial root, it should be carefully extirpated. This is one of the Mint tribe of plants before referred to.

10. The Dock genus comprehends a variety of species known to the farmer as weeds. These plants produce a large quantity of seeds, which they readily mature. The seeds are heavy,

and though diffused by the smaller birds, to which they serve as food, they are not so readily disseminated by the winds as those of the thistle kind. They, however, vegetate freely when they fall on the ground, and produce plants, which, when once allowed to extend their roots in the soil, it becomes difficult to exterminate. The roots are vivacious, and, if cut into pieces, the separate parts will send forth shoots. It is more easy, however, to raise up the roots of docks than of thistles by means of instruments, which receive the lower part of the stem in a cleft, and being used as a lever, wrench the plant from the ground. But the only effectual method of extirpating docks, as of most other weeds, is by summer fallow or cleaning crops. The seeds of docks are often conveyed to the farm mixed with grass-seeds. When this takes place, the docks will frequently establish themselves with the grasses, and grow vigorously the second year. They should be then pulled up by the hand, so as to prevent their running to seed and further overspreading the ground. The species of docks are very numerous. The most common is the broad-leaved dock, which is found in every country of Europe. In this country, it generally indicates a good soil.

11. Amphibious Persicaria is of the same natural family as the docks. On damp deep soil it is sometimes very abundant, overspreading the surface when the land has been left in grass. The prevalence of this plant generally indicates the need of draining.

12. The Great Nettle is frequent in waste places, under walls, and in hedge-banks. This species grows over all Europe, and is found from Barbary to Siberia and Japan. In this country it generally indicates a good soil. When it takes root in pastures, it is very difficult to extirpate it. It forms patches on which other plants will not grow. It may sometimes be destroyed by cutting the plant, so as to enfeeble it, and sometimes it is dug up by the roots. But when it prevails in pasture grounds to any extent, the proper remedy is a course of tillage.

Several of the grasses are known as weeds, which, from their creeping or vivacious roots, it is difficult to extirpate.

13. The Marsh Bent-grass extends itself not only by its creeping roots below the surface, but by its stolons or suckers above ground. Others of the genus extend themselves in the same manner in wet situations. They receive the names of black couch, black twitch, or black wrack.

14. The Common Oat-like grass has bulbous roots, whence it is called by farmers knot-grass. It is a very troublesome weed in many soils. The little bulbs when detached from the root, grow again, so that very careful tillage is required to extirpate the plant when it takes possession of a piece of ground.

15. Creeping Soft-grass is another plant, which, when it takes possession of ground, is not easily rooted out. It has a strong creeping root: but the species is comparatively rare.

16. Common Wheat-grass or Couch-grass, is called likewise quick or wrack, and receives many other names. It is the most abundant of the perennial weeds of corn lands. Its roots are creeping, and every part of them left in the ground will grow; and hence the difficulty of extirpating the plant. The most effectual mean of doing so, is by frequent ploughing and harrowing, and collecting the roots by the hand. This constitutes, as was formerly seen, an important part of the process of the summer fallow, and preparatory cleaning crops. There is no weed which requires so constant a vigilance on the part of the husbandman as the creeping wheat-grass; but it is well that, in contending with this perpetual enemy, he is compelled to give a more assiduous tillage to his land than he might otherwise be induced to do.

These different grasses are frequently all confounded under the name of couch, quick, and wrack,—names sufficiently indicating their characters.

17. The Soft Rush, with other Junci, are all to be regarded as weeds when they prevail amongst the better plants. They indicate wetness, and are only to be effectually removed by draining.

18. The Heaths are a widely extended family, covering a large part of the north of Europe. Where they intrude amongst the cultivated plants they are to be regarded as weeds.

Many other shrubby plants are found in unimproved land, and one of the first objects of cultivation is to extirpate them. Fallowing and liming are the usual means by which this class of plants is destroyed.

The Whin is one of the class of shrubby weeds. It requires continued culture thoroughly to extirpate it; for, after being apparently subdued, it will spring up again in great numbers, and for successive years. When the land is in grass, the young shoots may be sometimes pulled up by the hand, after the land has been saturated by rain. But when whins have thoroughly established themselves in the soil, and extended their roots, they must frequently be hoed up before the plough can act. The land being then ploughed with a good furrow, the remaining roots are torn up, and the plants at length destroyed. On elevated sheep-farms, whins should be encouraged rather than destroyed, for in such situations they afford shelter and food.

Broom is a shrubby plant for the most part more easily extirpated than the whin, though in certain situations it grows with great pertinacity. It affects the lighter soils.

Brambles, and other shrubs of the Rose family, are often the possessors of unimproved soils. Certain species of the bramble are very tenacious of their situation. These plants are destroyed by the same means as the whin; and the like remark applies to all the larger shrubs.

19. Another class of weeds is the acotyledonous, or flowerless plants, at the head of which stands the Fern. Of the fern or fern-like plants, there are many species in this country. They grow chiefly in mountainous tracts of natural pasture.

20. The last in order of the weeds are the Mosses. These plants are altogether innutritious. They often intrude extensively on pasture-ground, and supplant the herbage-plants. The best remedy in all cases is a course of tillage, and the application of lime.

The list of perennial weeds might be greatly extended. They differ in their characters and habits of growth, but they are all of them eradicated by careful tillage, chiefly during the period of the summer fallow and cleaning crops.

IX. MANAGEMENT OF GRASS LANDS.

1. FORAGE.

The produce of land which is designed for the feeding of animals may be consumed in three ways:—It may be eaten upon the ground where it grows; it may be cut down and given to animals while it is yet green, which is termed soiling; or it may be dried in order that it may be preserved, when it is termed hay.

The plants employed for these purposes are the different forage and herbage plants which have been enumerated, some of which are chiefly applicable to herbage, some to green or dried forage, and some to either of these purposes.

The clovers and similar leguminous plants mixed with grasses, may be applied alike to forage and to herbage. They form what in common language are termed the artificial or cultivated grasses; and land when producing them is commonly said to be in grass.

The seeds of the grasses and leguminous plants are to be sown in spring, in the manner before described, upon the surface of ground sown with the cereal grasses. When the crop of corn had been sown in autumn, the seeds of the clovers and grasses are sown in spring amongst the growing crop, the harrows passing over the surface with a double turn. When the corn itself is sown in spring, the grass seeds are also sown, just before the last turn of the harrows, and then the roller is frequently employed to complete the process. The seeds are sown either by the hand, or by the broad-cast sowing-machine, which regulates better the quantity, and sows them with more regularity. Care must be taken that the seeds of the grasses be sound and of the proper kinds, and that those of the clovers be fresh and well ripened, which will be shown by the shining appearance of the seeds; and great care must be used that those of either kinds be free from the seeds of weeds.

The proportion in which the different kinds of clovers and grasses may be sown together, is chiefly dependent upon the longer or shorter period for which the land is to remain in grass.

The seeds of the clovers and grasses may be sown in autumn as well as in spring, without any corn crop; and this practice has been recommended, in the case of laying down land to permanent grass, as being calculated to afford a quicker and better sward: and so indeed it may do; but then it is by the sacrifice of a crop of corn, which is too great to be disregarded in the practice of the farm. Cases may exist in which the value of permanent herbage is so great, with relation to that of corn and other crops, that this sacrifice may be made; but, in the great majority of cases, the advantages to be derived from the practice will in nothing compensate the increased expenditure. There is no difficulty, under good management, of getting the seeds of grasses and clovers to vegetate under the shade of corn in sufficient quantity to stock the ground; and in the forming of the meadow, therefore, there can seldom be a reason for deviating from the simple and economical practice of sowing the seeds of the herbage and forage plants along with the crop of corn.

The seeds, when sown, quickly vegetate, the plants springing up under the shelter of the larger crop; and in autumn, when it is reaped, they will be seen to be covering the surface.

In autumn, the ground may be slightly depastured with sheep; but heavy cattle which would injure the surface, should not be put upon it, and sheep only for a short time. During the period of winter, the land should remain untouched.

In the following season, the plants may be consumed in either of the three ways that have been mentioned:—

1st, They may be depastured with live stock.

2d, They may be mown two or more times during the season for green forage, and the aftermath depastured.

3d, They may be made into hay, and the aftermath depastured.

When they are to be employed in the first of these ways namely, for herbage, they may be depastured either by sheep or the larger cattle. Sheep may be put upon them in April or sooner, while they are yet short; but cattle should not be put upon them till the plants afford a full bite, which will usually be in May.

There is no period in the growth of these plants, at which they will afford so early and rich an herbage as in this, the second year after they are sown, or when, in the language of farmers, they are one-year old grass. They will feed the larger cattle perfectly. But it is to sheep that they are in a peculiar degree adapted; and, in the practice of the farm, the larger cattle are usually put upon the old grass, while the sheep are fed upon the young grass.

Whether, in any case, a field of young grass shall be applied to herbage or forage, is dependent on considerations of expediency and profit. If there shall be stock upon a farm requiring good and early grass, it may be most advantageous to use the new grass for herbage: in certain cases it may be more advantageous to employ it in soiling; in others to convert it into hay; and in the practice of the farm it may be applied to all these purposes.

When the grasses and clovers, or any other forage plants are to be used for soiling, they are mown with the scythe and carried directly to a house or yard, and put into a crib or rack, the animals being at the same time well littered with straw so as to be kept dry.

A field of young grass intended to be mown is managed thus:—When the land is sufficiently dry in spring, it is rolled so as to prepare the surface for the action of the scythe; and should any loose stones be upon the ground, they are gathered by the hand previous to rolling, and thrown into carts driven slowly along the ridges. Sometimes the ground may be too soft to bear the carts, and in this case the stones may be laid in little heaps in the furrows until it is convenient to remove them. These operations should take place in the end of March, or as early as possible in April.

In the northern parts of the country, it is usually the beginning of June before the process of mowing can be begun, but in the southern parts mowing may commence several weeks earlier. The field, or part of a field, reserved for the purpose, is then mown daily in such portions as are required for each day's feeding, and the forage given in its green and juicy state to the feeding animals. While the field, or portion of the field, is thus being gone over, a second crop will have been springing up. Beginning then with the part which had been first mown, the ground is again to be mown daily until it is passed over a second time. In this manner, two crops or cuttings will be obtained, and in favourable situations three. Should there be an interval between the cuttings, that is, should the second crop not be sufficiently ready after the field, or part of the field, has been passed over, then some food must be provided for the feeding animals in the mean time. The best provision in this case is the tare, which is one of the reasons for cultivating this plant on farms where soiling is practised.

The practice of soiling has certain advantages over the more common system of allowing the animals to find their own food in the fields. Their provender is brought to them, and none of it is wasted by their treading it down, while they are freed from that disturbance to which all animals are subject in summer and autumn from insects. It is found, accordingly, that the larger animals feed well under this system, and that a smaller space of ground will be sufficient for feeding an equal number.

As a country becomes rich, highly cultivated and populous, soiling is the manner of feeding which will naturally prevail. Hence it is practised in this country in the neighbourhood of cities where the land can be kept fertile: and it is the system adopted in some of the richer parts of Europe, and in an especial degree in the Netherlands, whence we have derived it.

But although soiling be the most profitable system of feeding where it can be adopted, yet in this country it is in many cases not practicable, and in certain cases not expedient.

The cases in which it is not practicable, are when land does not possess a sufficient degree of natural or acquired fertility to produce good and early crops of grass, or when sufficient straw to litter the animals during the period of feeding cannot be obtained. A large proportion of the land of this country will yield an adequate quantity of grass for herbage, but not sufficiently early and good for regular soiling.

The cases in which soiling is not expedient, although it may be practicable, are when the animals to be fed require exercise to keep them in health and in a growing state. Thus oxen are the better for moderate exercise in their first or second year. Young horses absolutely require it; and even milch cows, although they may be fed in the house or yard, maintain their health better in the fields. To the habits of the sheep, the confinement of the house or yard is entirely unsuited; and although in some parts of Europe the system of soiling sheep is practised, it ought to make no progress in a country abounding in pastures like Britain. A case in which soiling may be applied in all arable farms in this country is that of feeding the working cattle of the farm.

The next and most common method of applying the sown grasses and clovers is as dried forage or hay, in which state they can be preserved and given to the stock in winter, or at other times.

When the sown grasses and clovers are intended for hay, the land is to be cleared of stones and rolled in spring, as in the case of green forage. And when the plants are in full flower, and before the seeds are ripe, or even before the flowers of the clovers have in any degree begun to fade, the crop is to be mown.

The plants, by the action of the scythe, are laid in swathes, with their heads lying pretty regularly in one direction. The swathes lie for a short time to wither; and are then turned gently over by a fork, or the handle of the hay-rake, in such a manner that they shall not be broken and spread abroad. In 24 hours or more afterwards, they may be put into small heaps or cocks on every third or fifth ridge, according to the bulk of the crop, the ground being at the same time carefully raked.

It is a good practice to put up the hay green in these first cocks, and then to enlarge them by adding two together. If at this early stage they undergo a degree of incipient fermentation, it is no matter. It is in the later stages of the process that heating or fermentation may become hurtful.

When the hay has become dry in the cocks, the period of which will depend upon the weather, they are made into ricks in the fields. The cocks are dragged together by a horse with a rope, one end of which is attached to one of his traces, and the other end being put round the base of the cock, is fixed to his traces on the other side. He is then made to pull forward the cock to the place required; and in this manner two or more of them may be dragged forward at once.

The ricks are made by a person standing upon them to build and compress them. They are formed with a conical top, and are each bound down with a rope made of the hay itself. In this state they may resist a considerable fall of rain; but the hay is not to be suffered to remain longer in the ricks than is necessary to dry it in a sufficient degree to fit it for being stored in a larger stack. When the hay is sufficiently ready, which will be denoted by its feeling dry when the hand is thrust into the rick, it is carried in the large sparred cart (Fig. 56) to the place where the hay-stack is to be formed, which is most conveniently, in the barn-yard, near the stables.

The hay-stack may be built in a circular or oblong form; the latter is the most convenient when the quantity of hay is large. A number of persons being placed on the stack to build, the hay is forked up to them, and the stack, by the treading of their feet upon it, is compressed in proportion as it is raised. In 24 hours it will have considerably subsided, and in a day or two afterwards it is thatched with straw, and bound down with straw ropes; the loose hay of the exterior having been pulled carefully out all around, so that the whole shall present a neat appearance.

Hay, when put into a large mass of this kind, will undergo a slight degree of heat; but in the case of the clovers and grasses, the slighter the degree of heat at this period the better, and hence the necessity of a previous preparation of the material as careful as the state of the weather will allow.

Often great difficulty is experienced in the processes of the hay-harvest by the wetness of the weather. In such a case the farmer is obliged to watch the intervals of favourable weather, and employ every practicable means to forward the operations and secure the crop.

Some recommend the strewing of salt upon the hay, as the building of the stack proceeds. This is a good practice, as it corrects the tendency to fermentation, and renders injured hay palatable to stock.

In the making of hay, the great end to be aimed at is to prepare it as quickly as possible, and with as little exposure to the weather, and as little waste of the natural juices, as circumstances will allow. When we are enabled to do this, the hay will be sweet, fragrant, and of a greenish colour.

It is not usual to cut more than one crop of hay from the same ground in the year, although the second crop of the grasses and clovers may also be made into hay. It is never, however, so good as the first crop in weight and quality; and, besides, the late period of the season renders the preparation of it difficult or precarious. For these reasons the proper system is to depasture the aftermath, and not to make it into hay.

Wherever the system of the cultivated grasses is perfectly understood, they will never be mown for hay more than once. The first year's aftermath, and all the subsequent years' grass, so long as the land remains untilled, are to be used for herbage alone.

The produce of hay varies greatly with the quality of the soil and state of the season. About 2 tons per acre may be regarded as a good crop, but often the produce is greatly more, and then the crop is considered to be a great one. Hay, in the field-rick, weighs somewhat better than 112 lb. per cubic yard; after being compressed in the stack, it weighs to 180 lb., and when old about 200 lb.

Clovers, besides being raised for pasture or soiling, times cultivated for their seeds. In this case the cl

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cultivated should be sown by itself, pastured with sheep till pretty late in May, and then allowed to grow and ripen its seeds. When the seeds are fully ripened, the crop is cut down, and formed into very small cocks, which, after being thoroughly dried, are carried home, and put into stacks until thrashed. The process of thrashing is a somewhat troublesome one, from the difficulty of separating the seeds from the capsules. It is usually done by the flail; and the seeds may be winnowed in the same manner as grain, but with sieves adapted to the purpose. This species of cultivation, however, has narrow limits in this country. The crop is a great exhauster of the soil, and, from the late period of ripening and the extreme dryness to which the plants must be brought, it is a somewhat precarious crop, even in the more favourably situated parts of the island. For these reasons the greater part of the clover seeds consumed in this country is imported.

The grasses too, are frequently cultivated for their seeds. In this case the particular grass to be cultivated should be sown by itself. It should be dried and stacked like a crop of corn, and thrashed and winnowed. When a crop of this kind is cultivated, it should be regarded as an exhausting crop, and the land treated as if it had borne a crop of corn.

Sometimes the seeds of rye-grass are procured by a more partial process. The hay being put into cocks in the usual manner, it is thrashed just before being put into the larger ricks. The thrashing is performed in the field on a moveable floor of boards, placed upon a coarse canvass cloth. In this case the hay should be slightly beat by the flail, so as to detach the best ripened seeds without too greatly injuring or breaking the stems. The seeds are then put into sacks, and carried to the granary, on the floor of which they are spread and turned over as occasion requires. When dry, they may be dressed; or they may remain mixed with the chaff till
appeara The hay, however, is always injured where this sys-
Hay, ractised, both because it is deprived of the seeds, and
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grasses, tpen than would otherwise be required.

No method of producing hay has been found comparable to that of the cultivated grasses. Under this system, the forage-plants are cut when in their state of most luxuriant growth, and no manure is laid upon the surface in order to produce the hay; the manures being applied to the preparatory fallow or green crops, in which case they are covered by the plough and rendered entirely available. Yet over the greater part of England, land is kept permanently in grass for the purpose of mowing it, manure being applied from time to time to the surface. This system has become the very habit of the country, and, by the general adoption of it, beyond a question a vast public loss is sustained. The practice of the cultivated meadow was probably introduced into England by the Romans, and at a long subsequent period was made more fully known by the Flemings: and yet by far the greater part of all the hay produced in this island is derived from perennial meadows, and thus an expensive method of production substituted over a whole country for one more cheap and efficient. Certain peculiarities in the state of property in England, the effect of tithes, and the relative expense of keeping land in tillage and under grass, seem to have contributed to this so general substitute of the natural for the cultivated meadow. From habit, too, a preference is given to the hay thus produced. It is supposed by many to be more suited to keep horses in wind; and it may be so in the case of horses put to great speed, as the hunter and the race-horse; but, for the mere purpose of feeding, it cannot be doubted that the produce of the cultivated meadow, consisting of the superior grasses and clovers alone, in their young and most juicy state, must be greatly superior to that of the older grasses, mixed as they always are with a class of inferior plants. But if the large application of capital and the waste of land, for the production of this species of food, are to be regretted, in no other country are the farmers so diligent and so experienced in the management of the hay itself as in England.

The grasses to be mown are ready in the month of July and they are cut down when the greater number of their come into flower. When the land is of good natural quality, or when a ready command of manure exists, it may be mown every year for hay. But it is more common to mow it every alternate year, or every third or fourth year, according to its quality. It is then pastured in the intervening years, and in this way it is less exhausted than when mown every year.

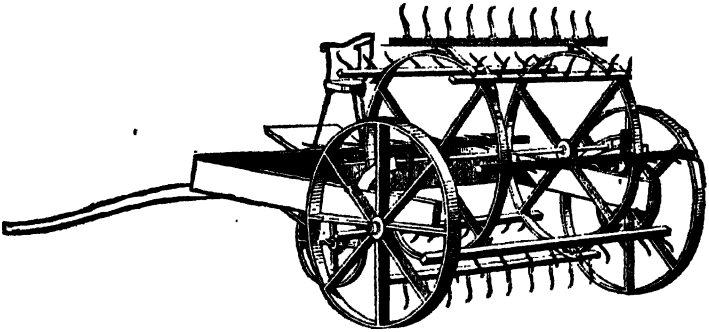
Land subjected to this species of culture requires to be manured at intervals upon the surface. When it is mown every year, the manures should be repeated every second or third year; but when it is occasionally pastured, the manuring may be less frequent.

The manures used may be of all the kinds applied to land in tillage. That most commonly employed in practice is the common manure of the farm-yard, well rotted. This is spread thinly and regularly over the surface, generally at the rate of 7 or 8 tons to the acre. The period of laying it on is various; some preferring to spread it in October, others after the hay is cut in July or August, and some in spring.

The grass, when mown, is soon afterwards tedded, or spread abroad with a fork, so as to be exposed to the sun and air. It may be turned over one or more times, and while yet green put into little cocks. The manner of collecting the grass together is by raking it into rows, technically termed wind-rows, the hay-makers in bands following each other with rakes until they have thus collected the whole into rows. They are then easily able, by hand labour, to form it into the small cocks described.

These first cocks are afterwards to be spread abroad, and, being exposed for a time, formed into larger cocks, termed sometimes bastard-cocks. In the county of Middlesex, where extreme attention is paid to the appearance and quality of this species of crop, the bastard-cocks are again spread abroad, and formed into yet larger cocks; after which they are carried home, sometimes on the fourth or fifth day. The object of this repeated spreading abroad, and forming into cocks, is to secure the hay in the shortest time, and with the least waste natural juices. This, indeed, is aimed at in all cases of making hay, but the details of practice are modified by the state of the weather, and vary in different parts of the country. Sometimes, to economize labour in these operations, hay-tedding and hay-raking machines are employed. The hay-tedding machine consists of a set of rakes placed horizontally. Motion being communicated to them from the wheels, by intervening pinions, they revolve in a direction opposite to that of the wheels, and lifting up the hay, carry it round, and scatter it behind the machine.

Fig. 179.



Hay-raking machines are of different construction. One nearly similar to that represented in Fig. 131. may be used.

Although the raising of hay on the natural meadow must be regarded as expensive, when compared with the raising of it on the cultivated meadow, yet there are soils and situations to which the practice is entirely suited, and in which it is the best method at the command of the farmer of obtaining dry forage.

One of these is the case of marshes, swamps, or bogs, producing naturally rushes, sedges, and the larger grasses. These marshes are of every degree of natural fertility, sometimes producing chiefly the *Carices* and *Junci*, and at other times producing the grasses of wet ground, as the *Poa aquatica*, *Poa fluitans*, *Agrostis alba*, and other plants of marshes.

The lowest for the most part in the scale of fertility of these wet grounds, and yet of great importance in the elevated districts where they abound, are those which consist of a thick bed of peaty matter. These are usually termed bogs, and the produce consists chiefly of rushes, as the sharp-flowered jointed rush, and others. This species of hay is greatly less nutritive than that of the cultivated or finer natural grasses. It is generally regarded as a little superior to the straw of wheat, barley, or oats, and will, for the most part, bear cutting but once in the year. It is too coarse for sheep, but is adapted to the winter provender of cattle. To these it affords a valuable resource in all the more elevated pasture districts of this country.

As the soil of the marsh improves, so for the most part does the natural produce which it yields. In flat and alluvial tracts the hay of the marsh is often valuable, even where cultivated forage can be otherwise obtained. It is frequently, therefore, a question of expediency, whether a marsh shall be broken up for tillage or allowed to yield its natural plants. It may produce a great deal of manure without requiring any; it may furnish a valuable resource to wintering stock ; and it may not be capable of being fitted for cultivation but by a considerable expenditure of capital.

The manner of preparing the hay of marshes, is similar to that of preparing the hay of the grasses already described, except that greatly less nicety is required. The rushes or grasses, after lying for 48 hours or more, should be tedded well, so as to receive the influence of the sun and air. After this operation, which is usually repeated once or oftener, the hay should be put into small cocks, and when sufficiently dried, put into ricks, to remain in them till the danger of fermentation is removed, when it may be carried home and formed into a stack. A slight fermentation in the stack may take place without injury, but care must be taken that this be not carried so far as to injure the hay.

There is another case in which perennial grass land, though not marshy, may be beneficially employed to produce hay. This is in elevated pasture districts, where cultivated forage cannot be obtained. In such situations, hay must be procured for the stock during falls of snow, and then the only means of obtaining it may be to set apart a portion of the herbage-land for mowing. This is a case produced by the peculiar circumstances of sheep-farms; and it does not invalidate the general principle, that hay is best produced on the cultivated meadow.

One other method, indeed, of producing natural hay free from all objection on account of the waste of manures, is yet to be considered. This is Irrigation; but irrigation applies to the production of herbage as well as dry forage, and we may, therefore, first consider the management of land in the state of perennial herbage.

2. Pasturage.

Much of the land of this country has never been cultivated, but produces without cultivation the herbage plants peculiar to it; such are all our mountain pastures, and the unimproved surface of the lower plains.

It is an error to apply the term waste to lands of uncultivated pastures. They are in no degree waste, but are employed in producing the species of food which, in the circumstances in which they are placed, may be the best which they are suited to produce. It may be supposed that, by cultivation, they will yield a more abundant produce, but it is always a question of prudence, whether the profit in cultivating them will be greater than that derived from them in their natural state.

A primary improvement of which lands unsuited to cultivation are susceptible, is freeing them from stagnant water. This is for the most part to be effected by affording an outlet to the water in channels cut in the most convenient places. This should never be omitted where the land is of sufficient value to repay the expenses; and it is rare, when land is of sufficient fertility to produce the grasses at all, that the expense of giving an outlet to the surface water will not be repaid by the increased value of the herbage-plants produced.

A species of draining, which has been practised to a great extent in some of the mountain districts of this country, is by means of narrow drains, about a foot in depth, made by the spade alone, carried along hollows wherever the water is likely to be interrupted. By this species of draining, an important improvement, at no great expense, has been effected in many mountain pastures; and the tendency to rot, one of the most fatal disorders to which sheep stock on wet lands is liable, lessened or removed.

Another method of improving the natural pastures of an elevated country is enclosing. In this way the animals of a farm are confined to the pastures which are suited to them, and permitted to feed undisturbed. And a great improvement of all elevated pasture-lands is shelter for the stock; and judicious planting, accordingly, is one of the means of increasing the value of exposed pastures.

But land is not only left in grass in parts of the country incapable of cultivation, or in cases where cultivation would not repay the charges incurred, but much even of the better land is kept in grass, when it is found that in that state it yields a more safe and steady profit than if cultivated. It is also, in all cases, a renovation of the productive powers of cultivated land to allow it to remain for a period in grass; and hence a large proportion of the whole country remains in that state.

The animals that may be pastured on all lands under grass are our different kinds of herbivorous stock. Cattle and horses require a large quantity, and though they prefer the finer grasses, are satisfied with a coarser herbage than sheep. Hence, a rule of the farm is to put sheep on finer and shorter grasses in preference to cattle and horses, and cattle and horses upon the larger and ranker pastures.

Whatever be the animals that are turned out to pasture, the rule is, that the pastures shall never be overstocked; that is, that there shall always be a sufficient quantity of food for the animals.

When animals are kept in the fields during the months of winter, they must of necessity remain there till the herbage rises in spring. But when they are not kept throughout the winter in the field, they are not usually put to the pastures in spring till these are sufficiently advanced to receive them. The usual period is April or May when our various animals are put into their respective pasture-fields for the summer.

The benefits of freeing lands from injurious wetness have been adverted to in the case of upland pastures. They are yet greater in the case of the pastures of the plains, inasmuch as the relative value of the land is greater. In this case, not only should surface-water be carried away by ditches and open drains wherever necessary, but under-draining should be resorted to, to free the land of wetness. By removing under-water, a more valuable species of herbage is produced, and the tendency to produce inferior plants lessened.

In the management of land kept in pasture, no manuring is required to maintain its fertility, which will be increased and not diminished by the effects of pasturing. Any species of manure, however, will add to the productiveness of land in grass; and when, from any peculiar cause, it is thought expedient to manure land in grass, the best kind of manure is usually lime, or composts of earth and lime. These are simply spread upon the surface, when vegetation has become inert at the fall of the year, or before it has become vigorous in spring.

The surface of land kept in grass becomes uneven from several causes. One of these is of yearly occurrence, the labour of the mole. In spring the mole-hills should be spread regularly by the hoe or spade; and, to prevent the animals from becoming numerous, they are taken in traps.

Another creature, too, scarcely known in some parts of the country, but very troublesome in others, is the ant. The hills raised by the ant are unsightly and hurtful, and there is great difficulty in driving the little creatures from the habitation which they have so carefully constructed. The hills, forming little eminences like small hay-cocks, will sometimes cover a large part of the surface. The methods recommended for destroying the ants are, raising the sods containing them by the spade, and burning them in heaps; or, just before winter, dividing the ant-hill with the spade, and laying the contents upon the surface.

The chief injury, however, which land when left long in grass is apt to sustain, is the decay of its herbage by the springing up of inferior plants. The most common of these are the *Musci*, Mosses.

The mosses are altogether innutritious. They occupy the place of the herbage plants, and thus render the pasturage of less value. They are most apt to grow where the soil is inferior and moist.

The best method of destroying this class of plants is by draining and liming; and old grass-land, when overgrown by these and other unproductive plants, should be taken up and undergo a course of tillage.

When it is inconvenient to break up the land, or when it is wished for any good reason to retain it in grass, the improvement of the sward may be attempted without tillage, although this will be found to be more expensive and less effectual. Rakes and harrows, with close-set teeth, may be employed to pull up the mosses; but this, which is merely a palliative, leaving the cause of the production of the plants unremoved, should be accompanied with draining, when necessary, and the application of calcareous matter to the surface. A somewhat more efficient mode of improvement is, to pare off the surface with the spade to the depth of a few inches, and then, after stirring with the harrow the soil below, to replace the sod. The productive powers of old turf will be renovated by this process, and especially if any lime or calcareous manure is applied before the sod is replaced.

When land is kept in grass, weeds of various kinds may tend to occupy the ground in place of the more useful herbage. The smaller kinds of these can only be eradicated by improving the ground itself. The larger weeds, as thistles, docks, ragweed, and others, should be pulled up or cut over when they come into flower, or before it. The best instrument for the latter purpose is a little spade, carried in the hand, by which the stem of the weed is cut at or below the surface. The scythe, too, must be used, to cut down such plants as tend to overshadow the ground: and this should always be done before they have ripened their seeds. Whins, when old, must be hoed up, which is generally an unsatisfactory operation; but young whins may frequently, when the weather is moist, be pulled up by the hand. All suckers of trees, too, should be pulled up as soon as they appear.

The very detail of these circumstances, however, shows the expediency of taking up old turf for a course of tillage whenever it tends to produce injurious plants. It is in this way only that they can be thoroughly eradicated, and their place supplied by better herbage.

3. IRRIGATION.

The fertilizing effect of water on the earth is one of those natural phenomena which everywhere force themselves upon the attention of mankind. Water is seen to be essential to vegetable life. In those climates where evaporation is the greatest, Nature has generally provided the most plentiful supply of this fluid, in rains and dews. But the rains often occurring at a particular season of the year, are insufficient for the life and nourishment of useful plants during the remainder, and the art of the irrigator is therefore necessary to produce fertility. Without the artificial conveyance and distribution of water, some of the most fertile countries in the world could not have supported their inhabitants; and the earliest husbandmen accordingly knew and practised the watering of lands as an art. In Egypt, where the great inundation of the Nile soon taught the inhabitants the value and uses of irrigation, this art is known to have been practised on a scale of surpassing magnitude; and the canals and vast artificial lakes of that celebrated people, though less enduring, are more praiseworthy monuments of their genius, than all the temples and cemeteries with which they have covered their country. From the valley of the Nile, it is to be believed, the knowledge of the art would be extended to many countries. To the Greeks and the Romans it was well known, and the rustic writings of the latter abound with allusions and rules relating to the watering of land. Without water collected by art, rice, which furnishes food to the greater part of the human race, could not be cultivated; and over the vast regions of Southern Asia, accordingly, the watering of land from rivers, brooks, lakes, and wells, is a labour essential to the support of the inhabitants. In all the southern countries of Europe, the art is more or less practised. It is there that the water is conveyed in little channels to the corn fields, to the vineyards, and to the olive-trees. The conducting of it from the rivers and canals, and measuring it out in determined quantities, form, in several parts of Italy, a nice part of the science of engineering. In Piedmont, and the whole valley of the Po, the water is frequently paid for by the hour, and the utmost care is bestowed in economising so precious a substance.*

The main object of irrigation, however, in all the intertropical countries, and in the warmer parts of the temperate zones, seems merely to be to convey to the ground that quantity of water which is necessary for the growth and nourishment of the plants to be produced. Sometimes, as in the case of rice, the earth must be saturated for successive months, and, in others, merely watered at intervals, during the periods of greatest evaporation. In all these cases the main purpose is the same, namely, to supply the deficiency of water in the soil; and this creates a great distinction between that species of irrigation which has been described as called for by the wants of man over so great a part of the globe, and that to which we apply in England the term watered meadow.

In the latter case, the purpose is not to supply the deficiency of water in the soil, for the water is conveyed over the surface at those times, namely the months of winter, when there is an excess, and not a deficiency of moisture. Nay, it is held necessary in every well-formed watered meadow, to drain the ground very thoroughly of all subterraneous water. Nor is this the only distinction between the two kinds of irrigation.

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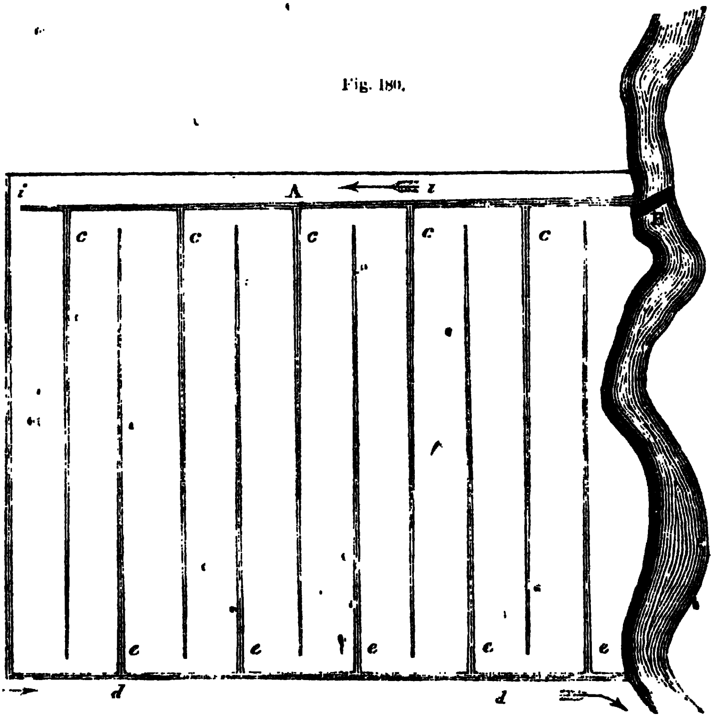
* Paper by me in the Quarterly Journal of Agriculture.

In the one, the water is generally allowed to stagnate until it shall have saturated the soil; in the other, it is never allowed to stagnate, but is maintained in a constant flow over the surface.

In one respect the two kinds of irrigation may serve a common purpose, that is, by the deposition of mud or other fertilizing matter upon the surface. The principal effect, we may believe, which the Nile produces in its periodical overflowings, is the supplying to the soil of the mere element of water, without which an arid soil, in a country where the rain is scarcely known, would hardly produce any thing. But this effect is plainly greatly increased by the large quantity of mud which the river deposites. In the case, too, of the watered meadow, the water may, in like manner, deposite a fertilizing sediment; but this, though it always adds greatly to the effect, is not essential to the producing of it; and waters entirely free from

Fig. 180.



all perceptible sediment, are yet successfully employed in the case of the watered meadow.

In the watered meadow, a stream of water is to be conducted to the surface, and caused to flow over it in a constant manner; the meadow to be watered, for the most part lying upon the bank of the river from which the water is conveyed, and forming a flat surface, or rather a gently inclined plane. To the highest part of this inclined surface, the water is conveyed in what is termed the main conductor, either by building a wear or dam across the river where the water is to be taken off, or by bringing it from a higher source. In the preceding diagram, A represents the main conductor, and B the wear or dam.

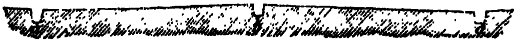
From the main conductor, and as nearly as possible at right angles to it, are taken off the various feeders, *ccc*, &c. These consist of small trenches 4 or 5 inches in depth, made widest, as a foot or 16 inches, where they issue from the main conductor, and gradually lessening as they recede from it. They may be formed at the distance from each other of 40 feet, or less, being nearer where the soil is stiff and retentive, and further distant where it is loose and porous.

The water is thus conveyed to the surface of the meadow. But it is necessary that it should maintain an equal flow over the ground, and so be carried off as quickly as it is admitted. This is done by means of the main drain *dd*, formed at the lower part of the meadow, and the several smaller drains, *eee*, &c. passing between the intervals of the feeders, in the manner shown in the figure. These small drains are of the same dimensions as the feeders, but are larger where they enter the main drain, and become gradually smaller as they recede from it. The main drain conveys the water back to the river from which it was taken.

But often this main drain becomes in its turn the main conductor to another meadow on a lower level. For the water which had floated the upper meadow being collected in this drain, can be carried from it by means of feeders in the manner described. and again collected in a drain below: and in this manner various meadows may be successively floated by means of the same water. And even where the lower meadows are nearly on the same level as the higher, it is still expedient to resort to this repeated collection of the water in drains, for it is found in practice difficult to preserve the equal flow of the fluid over a very large extent of ground.

In order to keep the water as it descends through the feeders, at the necessary level, and to cause it to overflow the surface, it is interrupted in its course by what are termed stops, placed in the feeders. These sometimes may consist of small pieces of plank, each resting on two little stakes; but oftener they are merely sods placed in the feeders, which are sometimes fixed down by wooden pins. It is the province of the person who superintends the meadows, when floated, to adjust these stops in such a way as to maintain an equal current over the ground. Further, in order to convey the water quickly from the feeders to the drains, the surface of the meadow is generally formed into low ridges, the feeder being on the top of the ridge, and the drain in the hollow, a transverse section of which would appear thus:—

Fig. 181.

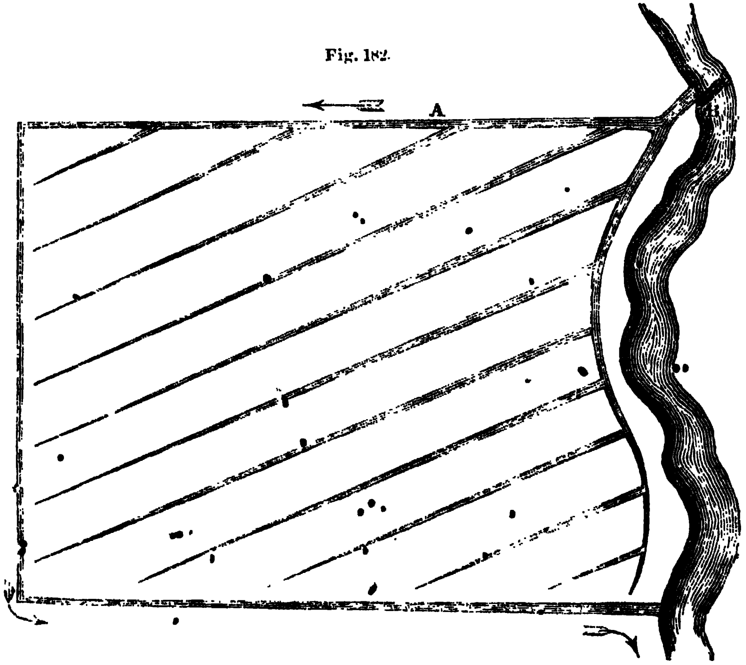


Here *b* represents the feeder, and *aa* the drains. In the language of the irrigator, the interval from *b* to *a* is termed a pane; and in Fig. 180 the space *i i*, which is left for a carriage-way above the main conductor, is termed the main pane, and is watered from the main conductor.

This is the most perfect form of the watered meadow. But when the inclination of the plane of the surface is considerable, a different principle must be adopted, for the conveyance and distribution of the water. In this case, the feeders are not carried longitudinally through the meadow, but across the line of the descent, in the manner shown in Fig. 182. Here the several feeders are filled as before from the main conductors; but the water having overflowed the lower side of the banks, is not discharged into smaller drains, as in the former case, but into the next feeder lower down; and is thus conveyed from feeder to feeder, over the entire space of the meadow. This species of irrigation is termed catch-work, and, as it can be adopted where the surface is too much inclined to admit of the flat meadow, it is frequently practicable where the other is not, and is often combined with it in the same meadow where there are inequalities of surface.

The process of floating the meadow commences generally in the month of October, being as soon as possible after the aftermath has been consumed, or the last crop of hay removed. The water is kept upon the ground for periods of a fortnight or three weeks at a time. It is then let off, and the ground laid perfectly dry for five or six days; and this process of alternate flooding and drying is continued generally during the months of November, December, and January, care being taken to let off the water, when it begins to freeze. As the spring advances, and the grasses shoot forth, the periods of watering are shortened, so that the flooding shall not last above five or six days at a

Fig. 182.



time. In the southern counties of England, the meadows are ready for the reception of stock of all kinds in the middle of March; but more to the north, where the grasses do not make such early progress, the flooding is generally continued during the whole month of May. After this, it is discontinued for the season, and one or more crops of hay are produced. Flooding during the months of summer produces a rapid and rich vegetation. But it is by summer flooding, where it is practised, that the fatal disease of rot is introduced, so that no sheep should ever touch the meadows which have been flooded during the summer months.

The theory of the process of irrigation has not been satisfactorily explained. That the effect is not produced by the mere supply of deficient water, appears not only from the period at which the water is admitted, and when in our climate the soil is always saturated with the fluid, but from the circumstance, that the effect is not produced when the water is allowed to stagnate, and sink down in the soil, but when it is kept in a current over it. When the water is suffered to stagnate, the soil tends to produce carices, junci, and other subaquatic plants; but when it is kept in motion, and drained off at intervals, the finest grasses peculiar to the soil and climate are produced. Neither does the fact of the deposition of mud, or other fertilizing sediment, explain the phenomenon; for however such depositions may increase the effect, it is likewise found that water, without the least perceptible sediment, may be employed with success. It has been supposed, that the water acts beneficially, by maintaining the soil at a higher temperature. Water at a temperature of 40° is of a greater specific gravity than at a lower temperature; and hence, as the water tends to the freezing point, the warmer portion of it is next to the ground.* Much, however, cannot be ascribed to this cause, in a current so shallow and constant as that which passes over the watered meadow. It is probable, therefore, that the main effect is produced by a mechanical action of the water, acting upon and bringing nourishment to the fibres of the roots of the plants.

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* Sir Humphry Davy's Agricultural Chemistry

England is perhaps the country in which the watered meadow, as the mean of producing hay or herbage, is the best understood, and the most extensively pursued. There is no reason to doubt that this art, like so many others, was derived from the Romans; and circumstances have conduced to its extension in England even more than Italy.

England is well suited to the production of the common grasses. These grow with a closeness and variety in the species unknown in more southerly countries, and with a vigour which ceases in higher latitudes. The rivers, too, in England, particularly in those parts most celebrated for this branch of husbandry, are generally turbid, and, flowing through a fertile and cultivated country, are enriched by the animal and vegetable matters which they receive in their progress, and thus not only irrigate, but manure the lands to which they are conveyed. The counties of Gloucester and Wilts have long been the most celebrated for their irrigation; but there are now others perhaps not inferior to them in the extent and perfection to which the practice has been carried. In the north of England, the practice almost ceases; and on the Scottish side of the Tweed, it is yet hardly known as a branch of the rural art.

The causes that have prevented this extension of the practice of irrigation to the north of England and to Scotland, are to be sought for rather in circumstances peculiar to those parts of the island, than in any indisposition on the part of the agriculturists there to adopt beneficial improvements. The useful effects of irrigation decrease with the diminished temperature of the climate. The rivers in the north generally flow through a smaller tract of cultivated country, and thus do not in the same degree receive those enriching substances which aid the purpose of irrigation; neither do their banks generally present those extensive flat plains so favourable to the art in the chief irrigating counties of England. But, hardly less than even the effects of climate and natural causes, a circumstance exists which retards the progress, and lessens the comparative importance, of irrigation in the northern parts of the kingdom: this is the general establishment of the alternate system of agriculture, and the economical means thereby afforded of producing hay by the clovers and cultivated grasses. The more costly system of tillage adopted in the greater part of England gives a higher relative value to land kept permanently in grass, and to the hay of the indigenous grasses, than in districts where a rotation of crops and cultivated herbage is extensively practised.

Although, for these reasons, the same value will never be attached to the watered meadow in the cultivated parts of Scotland, as in such counties of England as Wilts and Gloucester, it is to be desired that the art of irrigation were better understood in Scotland than it now is. Even in the best cultivated districts, there will always be pieces of land which may be advantageously used for the raising of hay as an addition to the provender of cultivated farms; and in the mountainous districts, forming the greater part of the whole country, where tillage on any considerable scale is difficult, inexpedient, or impracticable, the raising of hay for the support of live stock, during the severities of winter, is an object of primary importance; and, in this respect, the resources of the watered meadow may frequently be made available with the best results. The effect of water, applied on the principle of the artificial meadow, is in all cases admirable, with regard to the production of indigenous grasses. Its effect is speedily to eradicate heath, and those mosses or lichens which infest the surface and repress the growth of the nutritive plants; and, in all our mountainous districts, there is abundance of flat low land, barren, or productive only of the worst herbage in its natural state, which admits of irrigation from the innumerable rivers and streams by which such districts are traversed.

The formation of the surface of a watered meadow is a work demanding practical skill; and no one should think of attempting such a work, but under the direction of persons possessed of the required experience. The diagrams which have been given above illustrate the principle, but they do not in any degree exhibit the numerous variations that are required to suit the inequalities of the surface, the varying supplies of water, and other diversities of circumstances and situation.

Besides the watered meadow, properly so called, there is a species of irrigation which deserves the greatest attention, where local circumstances are favourable to it. This is when the liquid refuse of towns can be conveyed in drains or sewers to the land. This may be termed a species of liquid manuring rather than irrigating; yet it is found that the principles of the watered meadow, with respect to the mode of distributing and carrying off the water, are as applicable here as when the water is free from perceptible sediment.

Another species of irrigating is termed Warping. But the object of warping is merely the deposition of mud from turbid water, and it is therefore conducted on principles entirely different from those adopted in the case of the watered meadow. It is usually the water of the tide in flat rivers that is employed for the purpose of warping. This is admitted by sluices, and having deposited the earthy matter which it contains, it is allowed to escape. In this manner, by repeated depositions, a large quantity of earthy matter is left behind, and a new soil by degrees formed. On the estuary of the Humber, where this operation is carried on on the largest scale, the water, rendered turbid by the meeting of the tides and the fresh-water, is conducted for miles inland, and, in the course of a single season, about a foot of the richest soil is added to the former surface.

X. THE REARING AND FEEDING OF ANIMALS.

I. THE HORSE.

1. Species and Varieties.

In the genus *Equus*, naturalists comprehend 6 species, or animals nearly allied:—

1. Equus caballus—The Horse.
2. Equus hemionus—Dziggithai.
3. Equus asinus—The ass.
4. Equus quagga—The Quagga.
5. Equus zebra—The mountain Zebra.
6. Equus Burchellii—The Zebra of the Plains.

Of the species enumerated, those which have been domesticated in Europe are *Equus caballus* and *Equus asinus*, and a hybrid produced by these two species.

The Ass has been the servant of man from the earliest records of the human race. He has come to us from the South and East, and it is there that he is seen in his perfect state. Were we to judge of the value and importance of this creature from the feeble services he is able to render us in the oppressed and degraded state in which he appears in this country, we should form a very false estimate of his importance. He is the inhabitant of the desert, and an invaluable servant in the burning regions in which Nature has fitted him to exist. But yet more than this, he is endowed with the power of propagating a race of creatures of the highest importance to the inhabitants of many countries. The Mule, as an animal of burden in a rocky and precipitous country, far exceeds the horse or any other animal; and countries would remain separated from each other by impassable barriers, were it not for the matchless sagacity, patience, and surefootedness of the mule.

It is only, however, in the south of Europe, and in an especial manner in Spain, that the mule is to be regarded as important in the rural economy of Europe. Yet he is capable of being cultivated in the north of Europe, and possesses the hardy properties which fit him for innumerable kinds of lighter labour; and he can be maintained on far inferior feeding to the horse. There is difficulty indeed in rearing him to the same perfection in the colder parts of Europe as in the warmer, because the male parent, the Ass, cannot be brought to perfection in cold countries; and when the stallion is employed, the progeny, termed a Hinny, is never equal to the true mule.

The Horse, then, is that alone of the genus which interests us in this country as the subject of cultivation. The horse is strictly herbivorous, and more scrupulous with respect to the food he consumes than the ox. His stomach is comparatively small, and he eats often. He sleeps very little, and frequently standing, for which purpose Nature has made a peculiar provision in the form of his limbs. In sleeping he is startled by the slightest motion.

The horse is vastly modified in his form and characters by the physical condition of the countries in which he is naturalized. If fed in a country of plains and rich herbage, he tends to become large in his form; and such is the character of the horse of the plains of Northern Europe, as of Holstein, England, and other countries abounding in rich herbage. But in an elevated country, where the herbage is scanty, the size and form of the horse vary with the circumstances in which he is placed. There he becomes small, hardy, and capable of subsisting on the scanty herbage with which the mountains supply him. No contrast between animals of the same species can be greater than that between the horse of the mountains and the horse of the plains. The pony of Norway or the Highlands of Scotland, as contrasted with the huge horse of the Lincolnshire fens, presents such extremes of strength and size, that it is difficult to believe that creatures so different can be of the same species. Yet all this great diversity is produced by a difference in the supplies of food, as influenced by the effects of situation. Nor is this peculiar to the horse; the domestic ox and the sheep are subject to the same law, and in a no less remarkable degree. These animals are essential to the subsistence of the human race, and, by a beneficent provision of Nature, they are formed to adapt themselves to the circumstances in which they are placed.

The horse fed on the arid plains and scanty herbage of warmer countries, assumes characters and a form entirely distinct from those of the large and massy animals fed on the rich pastures of temperate countries. It is from this cause that the large horse of England and the northern plains of Europe contrasts in a striking manner with the lighter shape of the horse of other regions. As we pass from the northern to the southern parts of Europe, this change of form and character appears, but yet more when we have crossed into Africa. There the horse of the desert displays the light form and agile shape which fit him for his condition. We see that he is here the creature of the circumstances in which he is placed. The heavy horse of the plains of Germany and England could no more subsist on the dry and scanty herbage of Libya than on the heaths of Norway. The species would perish in conditions so different did Nature not provide a remedy, by adapting the animal to its condition.

The ancient horses of the North of Europe must have consisted either of the smaller horses of the mountains or of the larger horses of the plains. The horse which was chiefly employed for common uses, for war, for the tournament, and even for the chase, seems to have been of the latter kind. This appears from the accounts and representations given of him, and from the form which he yet retains when unmixed with the blood of the lighter races of the South and East. It is to this intermixture that the technical term *blood* is applied. Importations long ago took place of horses from Spain, from Barbary, and the Levant; and, at a later period, from Arabia. The African and Arabian horses, accordingly, have given their characters to the blood horse of England and its innumerable varieties.

The animal in which this effect of blood is the most remarkable is the English race-horse. For the combination of speed with the necessary strength, this creature can scarcely be surpassed. He forms, however, a race of artificial creation, admirably suited for a particular purpose, but not otherwise deserving of cultivation, except from this, that it is the stallions of this race that continue the excellence and purity of the parent stock.

The superior class of riding-horses, generally termed the hunter, is perhaps, the finest race of horses known. It combines the blood of the Arabian, and other races of the South and East, with the powerful form of the horse of the north of Europe, in a much happier proportion than the race-horse.

From the hunter, downwards to the races where no mixture of southern blood can be traced, the gradations are innumerable. It is in this class that our road-horses and hackneys, the horses employed in our coaches and carriages of all kinds, nay, often in the mere labour of heavy draught, are contained. It forms the most numerous class of horses in the country. But a large proportion is bad, having lost the hardiness and strength of the native race, without having arrived at the speed and other qualities of good breeding.

The remaining class of horses consists of those in which no mixture, or a very slight one, of stranger blood is found. These are the ponies of our mountains, or the larger horses of the plains. It is these last that interest the farmer as the animals of labour, and to them we commonly apply the term *cart-horse*, or *farm-horse*.

The variations produced in this class of horses by different effects of food and management are very great. But sometimes classes exist of them in sufficient numbers, and with characters sufficiently permanent, to allow the term *breeds* to be applied to them. The most commonly enumerated of these breeds are :—

1. The Old English Black Horse.
2. The Clydesdale Horse.
3. The Cleveland Bay.
4. The Suffolk Punch.

The Old English Black Horse may be said to be the native horse of the richer plains of England. He is chiefly bred in the midland counties from Lincolnshire to Staffordshire. These horses are of large size, with the breast broad, the thighs and fore-arm large and muscular, and the legs somewhat short. It is this variety which supplies London with those enormous dray-horses, which excite the wonder of strangers. The defect of this breed is the too great size of the individuals, their consequent slowness of motion, and their comparative want of action. These faults, however, may be corrected, and have been so very generally; and the true black horse of England affords the materials of an excellent breed. Mr Bakewell was aware of its value, and made it the basis of his improvement of the draught-horse.

The Clydesdale is the breed of the central plains of Scotland, though cultivated in elevated districts. The horses of this breed are less than the heavy black horses of the midland counties; they draw steadily, and are generally free from vice. They are reared by the farmers of the district, and have good justice done to them with respect to feeding and light work while in the hands of the breeders. It is to the good treatment of them when young that these horses owe much of their usefulness. Although, like the English black horse, somewhat deficient in action, they have properties which render them a safe and useful class of farm-horses.

The Cleveland Bays are so named from a district of Yorkshire, where they are reared, but they are, in truth, bred over the whole of Yorkshire and Durham. This breed has now more or less of blood. It possesses good action, and in this respect is superior to the black horse and the Clydesdale. It is said that the Cleveland bay has degenerated, but it is rather to be believed that it has partaken of that tendency to a lighter form, which the wishes of farmers favour. Excessive strength in the individual has everywhere become less valued than the power of active labour; and, partaking of this change, there is little reason to say that the Cleveland bay has degenerated.

The Suffolk Punch is so termed from its round or punchy [illegible] Normandy, which, from the [illegible] [illegible] acters, is probable. The Suffolk punch is not usu- [illegible] a tall horse, though compact, useful, and of exceedingly good action. This breed is in great request in the counties of Suffolk, Norfolk, and Essex, where it is preferred to every other for the plough. The Suffolk punches have been long remarked for the trueness with which they perform their work, and in an especial degree for their steady exertion at a dead pull. The breed has been crossed by the Cleveland bays, and many suppose that its genuine character has been deteriorated by this cross.

The Old English black horse, the Cleveland bay, and the Suffolk punch, are frequently crossed with horses of high blood, and the result is often animals of unequalled strength and beauty for the carriage, and sometimes for the saddle and the chase.

2. FORM.

An examination of the form of the horse requires a cursory one of his anatomical structure.

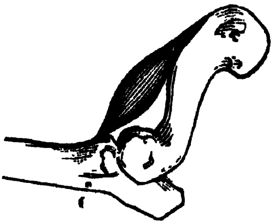
The bones of an animal form, it may be said, the foundation on which is erected the edifice of the living machine. They mainly give to it its form and proportions. Their various parts, connected by flexible ligaments, are capable of all the varieties of motion fitted to the condition of the animal.

Motion is given to the bones by means of muscles or fleshy fibre: but the flesh of animals is not a mere stratum covering the bones, as some might suppose. Every muscle is a distinct organ, consisting of innumerable parallel fibres, forming, as it were, a fleshy band, stretching from bone to bone, or from muscle to muscle, and each serving its peculiar function.

These muscles are of vast power when under the influence of the vital principle. By contracting, they give motion to the bones and other parts. Each muscle consists of long threads or fibres, seemingly bound together by mesh-work. These fibres, in so far as the eye, assisted by very powerful glasses, can discover, are resolvable into minuter filaments. A number of these filaments may be said to form a fibre; a number of these fibres to form a fasciculus or bundle of fibres; and a number of fasciculi to form a muscle.

Muscles assume a variety of form suited to their peculiar functions. Sometimes they are flat, extending over a considerable space, and often they form a fleshy band, swelling out in the centre, and becoming small and tendinous at the points of their attachment to the bones.

Fig. 183.



Not only is a class of muscles employed in giving motion to the bones, but a numerous class is employed within the body in giving motion to the organs of nutrition, as the heart and the stomach. Anatomists enumerate in all about 400 muscles, a number wonderfully small when we consider their functions, and the infinite variety of motion in the animal; for, from the motions of the limbs to the expression of the face and modulations of the voice, all is moved by this machinery of surpassing beauty and simplicity.

The bones, although harder than the muscular structure, are, like it, the parts of a living machine, furnished with their bloodvessels and nerves. They give to the animal its peculiar form, and, acted upon by the muscles, its power of progression.

The following figure represents the connexion of the principal bones of the horse:—

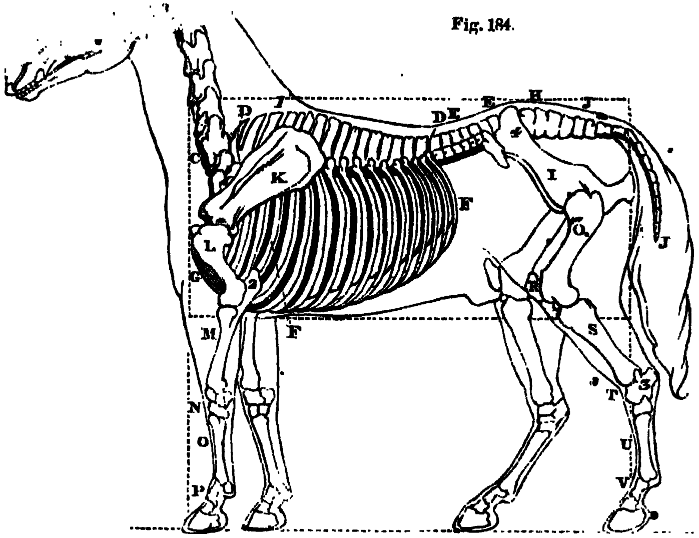


Fig. 184.

C, C, Cervical vertebræ.
D, D, Dorsal vertebræ.
E, E, Lumbar vertebræ.
A, Bones of the cranium.
B, Bones of the face.
H, Sacrum, or rump-bone.
J, J, Bones of the tail.
F, F, Ribs.
G, Sternum, or breast-bone.
I, Os innominatum.
Q, Os Femoris, thigh-bone or haunch-bone.
S, Bones of the leg.
R, Patella, or stifle-bone.
T, Tarsal bones, or bones of the hock.
U, Metatarsal bones of the hind-leg.
V, Phalangeal bones, or bones of fetlock, foot, &c.
K, Scapula, or shoulder-blade.
L, Humerus.
M, Fore-arm.
N, Carpal bones.
O, Metacarpal bones.
P, Phalangeal bones—
1. Withers.
2. The elbow.
3. Point of the hock.
4. Hip-bone.

The series of bones to which the others may be regarded as attached, is the vertebral or spinal column. This, in man, is erect, forming what is termed the back-bone. It is a pillar of bones, flexible and of great strength, serving to support the head and chest. These bones or vertebræ are jointed or articulated together, with a certain power of motion, and firmly bound by strong cartilage. Each vertebra has a cavity passing through its centre, so that, when all are united together, there is a continued canal passing along the whole column. It is within this canal that the continuation of the medullary part of the brain, or spinal marrow, is enclosed. Radiating from this, and passing through foramina or holes in the column, are nerves destined to give sensation and motion to the muscles and other organs.

In man the number of vertebræ is 24, in the horse 30; in man the column is erect, in the horse it is horizontal, to suit the position of a quadruped.

Of the vertebræ, those peculiar to the neck are termed cervical; those belonging to the back, and from which the ribs arise, dorsal; those belonging to the loins, lumbar. In man there are 7 cervical, 12 dorsal, and 5 lumbar, vertebræ: in the horse there are 7 cervical, 18 dorsal, and 5 lumbar, vertebræ.

These vertebræ have each projections termed processes, which are designed for the attachment of muscles, and of which the upright are termed spinous processes. In the horse, the spinous processes next the neck are very large, forming what are called *withers*. To them are attached muscles and ligaments which support and give motion to the head and neck; and large withers are connected with the power of active motion in the horse.

Jointed or articulated to the first of the cervical vertebræ is the head, containing the brain and the principal organs of sense. The bones of the head are divided into two classes, those of the cranium or skull, and those of the face. The bones of the cranium are distinct pieces, firmly united, and many of them dovetailed into each other, and forming a cavity fitted in the happiest manner for the protection of the vital organ within. The manner in which the cranium is articulated to the upper vertebra, is analogous to that in which the vertebræ themselves are united together. The cranium may be said to be itself a vertebra, its parts being merely expanded and enlarged so as to form a cavity for containing the brain.

horse they
may collect food. The
upon the summit of a column:
order that it may reach the ground, it is pen-
In the horse, its great weight is supported by powerful muscles, and by a strong ligament extending from the head to the spine. It is for the better attachment of this ligament and muscles, that the withers of the horse are large: in man withers are not required.

The prehensile organ of the horse being the mouth, and not as in man the hands, the length of the cervical vertebræ must be so much greater in the horse than in man, that he may be able to reach the ground and collect his food. Although the number of cervical vertebræ in the horse is the same as in man, their length in the horse is much greater.

The spinal column becomes larger towards the base, when it gradually diminishes. This portion of it forms what is termed the sacrum: the bones of it are not jointed, but united so as to form one bone. The vertebral canal is continued into the sacrum, and sends forth nerves to the lower extremities. In man the sacrum is terminated by 4 or five little bones united together: in the horse these bones extend to a greater length, forming the caudal vertebræ or tail.

Rising from the several dorsal vertebræ are the ribs. These bones are flat, bent, and elastic, and terminate in cartilage. Some of them are united directly to the sternum or breastbone: these are termed true or sternal ribs. Some are not united directly to the sternum: these are termed false or asternal ribs. In man the number of dorsal vertebræ and consequently of ribs, is 12 on each side. In the horse the number of dorsal vertebræ, and the number of ribs accordingly on each side, is 18, of which 9 are true ribs and joined to the sternum, and 9 asternal ribs. The other bones connected with the spinal column are those of the pelvis, to which is attached the bone of the thigh. Connected with the spinal column also by muscles, is the scapula or shoulder-blade, to which is attached the humerus.

The pelvis is at the lower part of the spinal column in man, and at the hinder part in the horse. It is a large irregular-shaped cavity, formed by the ossa innominata and other bones. It is within this cavity that the fœtus is developed and nourished. A prominent bone of the pelvis is the ilium or hip-bone.

Into a cavity of the os innominatum on each side is inserted the os femoris or thigh-bone, which is the largest bone of the body. The thigh in man is altogether detached from the trunk; in the horse it forms apparently a part of it. This is required by the different position of the animal, and the bone has sufficient facility of motion in the position in which it is placed. In man it stands vertical; in the horse it is bent, which prevents the animal from being raised too high above the ground. In this position, too, he has a greater power of progression. When he moves the limb backwards it describes a large arch of a circle. Now, were the thigh placed perpendicular to the ground, it will appear from the figure that, when stretched backwards, it would describe a smaller arch of a circle. Its length, therefore, combined with its bent position, conduces to the vast power of progression of the animal: and the comparative power of motion in horses is very much dependent upon the length of this part. This greater length of the thigh-bone, again, is indicated to the eye by the distance from the hip-bone backwards, forming what are termed the hind-quarters. Jockeys, accordingly, always look to the size of the quarters as connected with the rapid power of progression of the horse.

Next in order are the bones of the leg, consisting first of the patella or stifle bone, corresponding with the pan of the knee in man, and next of the two bones, the tibia and fibula, united in the horse, and forming the leg properly so called, and corresponding with the leg in man. The leg of the horse should be long in proportion to the lower parts of the limb.

The further bones of the limb correspond with the bones of the heel, the foot, and the toes of man. The bones of the heel in man are termed the tarsal bones; of the foot, the metatarsal bones; and of the toes, the phalangeal bones. In man the tarsal bones are in number 7, the metatarsal 5, and the rse, the bones corresponding to the phalangeal bones, are likewise, as in mber of bones adds to the flexibility of the limb.

Man, however, standing erect, requires a large pediment of support. The bones of the foot therefore are made to rest upon the ground. But the horse, having four limbs of support, does not require this large pediment. The metatarsal bones of the horse are therefore extended, in order to give length to the limb. The phalangeal bones form the fetlock and other parts, giving to them flexibility and elasticity; and the lowermost only of the phalangeal bones are brought into contact with the ground. These last are not separate as in man, but together, and defended with horn. The horse, therefore, may be said to stand on his toes; and if any person will attempt to walk on all-fours, he will find that the toes will touch the ground, while the bones of the foot will be raised up.

The bone of the horse termed the point of the hock, corresponds with the great bone of the heel in man. To this is attached powerful muscles; and the size of this bone, therefore, as giving space to the attachment of muscles, is connected with good action in the horse, and is therefore one of the points looked at by jockeys.

The bones of the other extremity of the horse correspond with the arm, the fore-arm, the wrist, the hand, and the fingers in man. In man the hand forms the prehensile organ, and a great flexibility is given to the different bones which form it. In the horse these bones form the limbs of support. They are not designed to seize objects, but to support the weight of the animal before,—to be raised from the ground when he pushes himself forward by the extension of the limbs behind,—and to receive his weight when he again reaches the ground.

The scapula or shoulder-blade is in the horse, as in man, a large flat triangular bone, placed upon the ribs, and connected by means of muscles with the head, the ribs, and the spine. In man, the two scapulæ are kept from approaching each other by the clavicle or collar-bone. From the form and position of the horse, this approximation cannot take place ; and there is therefore no collar-bone in the horse.

Into a cavity of the scapula is jointed on each side the humerus. But the humerus, or arm from the shoulder to the elbow, is in man detached as it were from the body ; while in the horse it seems to form a part of it ; and in this position it has sufficient power of motion. It is bent, as will be seen from the figure,—an admirable and necessary provision to lessen the shocks which the animal receives on bringing his limbs to the ground ; for by this flexure they act the part of a spring. Were these bones vertical, the limb would be shattered when it struck the ground.

The shoulder of the horse should be oblique, and the humerus relatively short. The obliquity of the shoulder is a point connected with action in the horse : and the reason why the humerus should not be long will appear from the function which it has to perform. When the animal moves the limb forward to raise it from the ground, the humerus has to describe an arch of a circle ; but the muscular power being sufficient, the shorter radius describes an equal arch with a longer.

The next of the bones are two, the radius and ulna united together in the horse, forming the fore-arm in man, and what is termed the fore-arm in the horse. The termination of the ulna, corresponding with the elbow, forms an important point of the horse, because to it are attached powerful muscles for the movement of the limb. Jockeys accordingly look with attention to the size of the elbow of the horse.

The remaining bones of the limb correspond with the bones of the wrist, the hand, and the fingers, in man, termed respectively the carpal, metacarpal, and the phalangeal bones

The carpal bones of the horse are commonly called the bones of the knee ; but these bones do not correspond with the knee, but with the wrist, of the human body. They are 8 in number in the horse as well as in man. In man, they give flexibility to the hand ; in the horse they give flexibility to the limb of support.

The next bones are the metacarpal bones. These correspond

they form a
se they are extended in

The bones of the fetlock and foot correspond with the phalangeal bones. or bones of the finger in man. They are distinct in man ; they are together in the horse, and, touching the ground at their extremities, are defended by horn.

The horse, abstracted from his neck, and viewed in profile, is contained nearly within a square, of which the body forms one-half and the limbs form one-half. In this respect the form of the horse differs greatly from that of the ox, the body and limbs of the ox, abstracted from the neck, being included in a rectangle, in the manner to be afterwards shown, and the body forming a greater proportion of the rectangle than the limbs. This circumstance would alone account for the greater power of progression of the horse than the ox.

In the horse, while sufficient space must be given in the size of the body to the respiratory and nutritive organs, this space must not be too great, because then the body will bear too large a proportion to the limbs for the purpose of active motion. In the ox the larger the proportion of the fleshy matter of the body to the limbs the better.

In the case both of the horse and the ox, the large expanded chest indicates a disposition to fatten ; but if this be carried too far in the horse, he will be incapable of active motion. Such a form may suit the dray-horse, when a large force is to be thrown upon the collar: but would be unsuited to those cases in which we require the power of active motion, or, in technical language, action.

In a horse where speed alone is required, the chest must not be too broad ; but in a horse in which we require active motion, combined with endurance, there should be a sufficient breadth of chest : and a medium, therefore, is what is desired in the hackney and the hunter. In the farm-horse, the chest should be broad ; because in the farm-horse we require the power of draught, and not of speed.

The chest of the horse behind the shoulders should be deep :

his back, when we look for strength without sacrificing this to mere speed, should be short; the ribs should approach near to the pelvis, as indicating strength. though, if speed alone be required, this point may be sacrificed. The fore-arm and hind-leg, to the joints, should be muscular, and below the joints tendinous. The trunk should be barrel-shaped, but somewhat elliptical, and gently enlarging from the breast backwards.

3. Rearing and Feeding.

In the breeding of the horse, it is important that the parent of either sex be free from disease. It is well known to all breeders, that the diseases of the parents, as well as their good properties, are transferred to their offspring In breeding, attention should be paid to the female as well as to the male parent, else disappointment may result with respect to the form and properties of the progeny.

A mare is capable of receiving the male at an early age; but it is an error to commence breeding from any mare before strength has been acquired, and her form developed; and this will rarely be sooner than at three or four years of age.

The mare comes into season in spring: she goes with young about eleven months, although with an irregularity, even to the extent of several weeks on either side of that period. The most convenient time for her receiving the male is in May, that she may foal in April, when the herbage begins to spring. From the time she receives the male till that of foaling, the farm mare may be kept at her usual work. She will give notice of the period of foaling, by the extension of the udder. and other symptoms, and she may then be released from work.

In general, little difficulty or danger attends the parturition of the mare. She rarely requires assistance; but, should difficulty really arise, from the particular position of the fœtus, it is well, if possible, to obtain the assistance of a veterinary surgeon, lest the mare be injured by unskilful and violent means.

As soon as the mare has foaled, she should be placed with her young. either in a house, or, what is better, in a pasture-

o at all times. It is ne-
with nourishing food.
in a field, and permitted
suckle the young undisturbed. But yet she may be put, without danger or injury, to moderate work within a short time after foaling.

For a time, the foal should be shut up in a house during the hours of work, which then should not be too long; but, after the colt has acquired a little strength, it may be permitted to follow the mother even when at work in the fields. Many, indeed, do not approve of this practice, on account of the chance of accidents to the foal. But accidents seldom occur, and the foal has an opportunity of taking milk more frequently, is the better for the exercise, and becomes used to the objects around it.

In 9 days or more after foaling, the mare will be again in season, and may receive the male. In 6 months the foal is to be weaned, which is done merely by separating it from the dam. It is then best put into a field: the mother is then put to her ordinary work, and treated as usual.

At the time of weaning, and during all the period of its growth, the foal should be liberally fed. Bruised oats, meal, or any farinaceous food, may be given to it. It is not necessary or proper that it be pampered; but it is important to its growth and vigour, that it be supplied with sufficient food.

The male foal intended for agricultural purposes must be castrated; and the best period for performing the operation is at the age of 12 months. Some do it before weaning, but it is better that it be delayed till the masculine form of the animal has been more developed.

If the colt be intended for the saddle, it is well that from this period it be accustomed to gentle handling by the person who feeds it, for this is a mean of rendering it docile and good-tempered. But however this be, nothing but kindness is to be shown to these young creatures, and any thing like rough treatment is to be carefully avoided.

The colts are kept in their pastures during the summer, and when these fail before winter, the animals may be put into a yard with sheds, and plentifully littered with straw, like the young oxen upon the farm. They may receive straw for half the winter, and hay towards spring when the straw becomes dry and unpalatable; and turnips, or any green food, should be supplied to them freely throughout the winter. It is a great error to starve colts, for this injures their growth and vigour in a degree far beyond the value of the increased food required. Although they may be confined in a yard in the manner described, it is greatly better, where convenience allows, that they have a piece of ground on which they may run in winter. This is favourable, in an eminent degree, to their health, and the state of their feet.

But, however the colts are managed in winter, as early in spring as the pastures will allow, they are to be turned out to graze in the fields, where they are to be kept during summer; and in the following winter put again into the yards or paddock, and treated in the same manner as before.

And they are to be treated in a similar manner in the following summer and winter; after which, namely, when three years old, they will be in a condition to be broken in, and, if draught-horses, employed in the work of the farm. They may be taken up for training even in the third autumn of their age, though at this period the work should be very gentle.

A farm-horse usually receives little training, though it is better that a partial training, as in the case of the horse intended for the saddle, be given. But whether this be done or not, the colt should have a bridle with an easy bit put upon him for a few days, and allowed to champ it for an hour or two at a time in the stall. The harness being then put upon him by degrees, he may be trained to the different labours required of him. In general, the farm-horse, working with his fellows, is easily brought to be obedient.

But when a farm-horse is four or five years old before he is put to work, or if he is a stallion, or if he shows any vice, a little more care may be proper, and a partial training, as if he were intended for the saddle, given him. And if he is a valu-

the carriage, the
e better.

ng the horse for the saddle is now well understood, and the rude and violent practices of former times are generally abandoned by all who have any competent knowledge of the subject. In every case, gentleness and kind treatment are to be strictly observed in the management of the colt. He is first to be taught his duties, and corrected afterwards only when necessary to enforce submission. Fear, in the training of the horse, is that feeling with which he is soon endued, that he is under the dominion of a more powerful agent, whose will he cannot resist. Implicit submission is to be enforced, gently in so far as instruction is concerned, but by calling into action the principle of fear, when this is required to produce obedience. Decision and firmness, with a resolution to be obeyed, after the horse has been fairly taught the duties that are required of him, are altogether distinct from violence and cruelty. Nothing is so destructive to the temper of a horse as useless coercion, and all the defects of temper, when they exist in the young horse, arise in the great majority of cases, from injurious treatment. But we are here chiefly to consider the management of the horse as an animal of labour.

The farm-horse demands, neither in the training nor in the feeding, that nicety which is required in the case of the horse designed for rapid motion or irregular labour. He requires merely to be maintained in good order, never to be worked beyond his power, and never to be allowed to fall, in condition, below the work which he is to perform.

The stable for the farm-horse, as for every other, should be spacious and well ventilated. It is a great error to suppose that horses require a close, warm stable, to preserve them in health. To keep them fully sheltered, and free from the action of any cold current, is all that is requisite. The horse is well suited to bear an equal temperature, but not sudden changes produced by artificial means. Farm-horses regularly worked have been known to be kept throughout the coldest winters in mere sheds, not only without injury, but with greater benefit to their health than if they had been closely confined.

Next to ventilation in importance, is cleanliness of the stable. No filth should be suffered to accumulate, but every day the stable should be cleaned out, with the same attention for the farm as for the saddle horse. In the farm-horse stable, every ploughman should have a small fork, a curry-comb, a brush, a mane-comb, and a foot-picker. (Figs. 86, 87, 88, 89.)

Light should be admitted into every stable, to a certain extent. But in the case of farm-horses, which are only in the stable during the hours of rest and feeding, less light is necessary than in the case of the saddle-horse, which passes a great part of his time within doors. The light required for the farm-horse stable is that which is sufficient to allow the workmen to perform their duties in the day-time. Sometimes there is a room adjoining the stable for holding the harness, but it is perfectly convenient and sufficient in practice to have the simple furniture of the farm-horse hung on pins in the wall behind each pair of horses.

The food of the horse in this country consists of herbage, or green forage, as clovers and sainfoin ; of dried forage, as hay and straw ; of various farinaceous substances, as oats, barley, pease, and beans ; and of the succulent roots of plants, as the potato, the turnip, the carrot, the parsnep, and the beet. Of the grains given to the horse, the most generally employed in this country, and that which is regarded as well adapted to his strength and spirit, is the oat.

The oat is, for the most part, given to the horse without any preparation, though it is sometimes bruised, which is always beneficial, by rendering it more easily masticated and digested. It is usually given in portions at a time, familiarly known under the term feeds, the measure of which, however, varies in different districts A feed in some places consists of a gallon, being the eighth part of a bushel, and weighing, upon a medium, about 4½ lb

Two gallons in the day, or 9 lb., are considered to be good feeding when the horse is on dry food, and not on hard work , when on hard work, the quantity may be increased to 3 gallons, and when on light work and green food, it may be reduced to 1 gallon, and sometimes altogether withdrawn. But on an average, 2 gallons in the day, that is, about 90 bushels in the year, will be sufficient in every case for the working horse of a farm. In practice, too, it is not the superior but the lighter oats that are given to the farm-horses. These are the light corn formerly described.

Oats may be given to horses reduced to a state of meal, but this is only practised in the case of gruel given to a sick horse. To induce a horse to take gruel, it is put into a pail and placed beside him, so that when thirsty he may drink of it.

Meal is sometimes given with cold water to horses, when travelling. This is a refreshing feed to a horse on a journey, and a safe one when the chill is just taken off the water; but it is chiefly employed in journeys when time is of importance, and it is accordingly rarely given in the case of the farm-horse, who should always have time given him to feed.

When oats are kept in a damp state, fungi grow upon them, and they acquire a musty smell and bad taste. They should never be given in this state to a horse, but should first be kiln-dried, so as to expel the moisture and destroy the fungi.

Barley is more nutritious than oats, although, in the practice of this country, it is not so much approved of in feeding. But over all the Continent, barley is the most common food of the horse. If bruised and mixed with chopped straw or hay, it is an excellent provender. But the most common method of giving barley to horses in England is in what is termed a mash. The barley in this case is boiled in water, and the whole is then allowed to stand until it is sufficiently cool. The mash forms admirable feeding for a sick horse; it keeps the bowels open, and is nutritive, without being heating.

Wheat is rarely used for the feeding of the horse, the proper destination of wheat being the food of man. The only case, in general, in which wheat, with a regard to economy, can be applied to the feeding of the horse, is in that of light wheat.

which, being made into a mash, may be given to a sick horse in the same manner as barley.

Beans form an esteemed food for the horse. They are somewhat more astringent than oats, and correct the tendency to laxativeness when it exists. They should in all cases be bruised, and mixed with other farinaceous food.

The pea is similar in its feeding properties to the bean, and is even supposed to be more nutritive. It is, however, a dangerous food to be given in too great a quantity, from its tendency to swell in the stomach. It should, like the bean, be bruised, and given along with other food.

The details in the manner of feeding the farm-horse necessarily differ according to the practices of different districts. The following is a system, simple, efficient, and capable of being reduced to practice upon every farm :—

When the pastures, or other green food, fail in autumn, which will generally be by the beginning of October, the horses are to be put on hard food. They should receive at this period an allowance of hay at the rate of 20 lb. in the day, with 2 gallons of oats; or, in place of a portion of the oats, they may receive at night a feed of steamed food, consisting of potatoes, or any other roots, mixed with a little corn, and seasoned with salt. The whole quantity may be a peck, weighing about 12 lb. The quantity of potatoes that corresponds in nourishment with oats, is in the proportion of about 15 lb. of raw potatoes to 1 gallon of oats.

In the months of November, December, and January, when the days and the time of labour are short, the hay may be withdrawn, and the horses, in place of it, fed on straw, of which the best, when it can be obtained, is that of beans or pease. Next to these in quality is that of oats. The straw of wheat and barley is in this country only used as litter, though, were it to be cut into chaff, it could be advantageously used as fodder.

At this time the horses should receive 2 gallons of oats in the day; or the quantity of oats may be diminished, and a portion of steamed food given at night. They should receive, as before, two feeds, one in the morning before going to work, and one at mid-day, and their steamed food at night. By the beginning of February, they should again be put on hay, in preparation for their harder work in spring. At or before the time of sowing the oats, that being the commencement of the season of active labour, the horses should receive their full allowance of 3 gallons of oats in the day, or, in place of a portion of their dry oats, a corresponding allowance of steamed food. They should be fed three times in the day, a feed of oats being given in the morning, a feed at mid-day between the intervals of work, and at night they may either receive their third feed of dry oats, or a corresponding quantity of steamed food mixed with their oats.

They are to receive this full allowance of hay and corn until about the beginning of June, when they may receive green food, on which they are fed during the remainder of the season, their daily allowance of oats being reduced to 1 gallon.

Three methods of feeding them on green food may be adopted:—they may be turned out to pasture in the fields; they may have green forage cut and brought home to them in the yards or stalls; or they may be fed in the intervals of work on green food, and turned out in the evening to the fields to pasture.

When the first of these methods is adopted, that is, when the horses are simply pastured, they are merely turned out to the field at night after work; they are caught again, or driven home to the stables, in the morning, and then again turned out after the morning's work, which may be about 10 o'clock, and allowed to feed till the afternoon's work, which may begin about 1 o'clock; they are then caught and again set to work.

The defects of this mode of management are apparent. Time is lost in taking the animals to and from the field during the intervals of work; and then, having to gather their own food, they have too short a time for rest and feeding during the interval.

The second practice mentioned is to turn the horses out to pasture at night after work, but in the interval in the middle of the day, to give them cut green forage, which is brought home, and given to them, in the stall or stable. In this manner they feed at leisure, undisturbed by insects, and having their food collected to them, waste no time in gathering it in those hours which are suffered to elapse between the labour of the morning and that of the afternoon. This is an approved method of managing the horses of the farm. Their health is the better for their being kept out at night, while the advantage of this is combined with the economical practice of soiling.

The other method of feeding is, to keep the horses constantly in the stable, or in a yard with sheds, and to feed them entirely on green forage. There is economy with respect to feeding in this system, and though it would seem to be scarcely so conducive to the permanent health of horses, as to give them a run out in the fields in the summer nights, yet it is found to be perfectly suited to the habits and condition of the farm-horse. Where it is practised, it is better to keep the horses in yards with sheds, than to confine them entirely to the stables. To carry on a system of soiling where clover and rye grass are the forage-plants employed, a quantity of tares, equal to ¼ acre for each horse, should be sown, to be given to the horses in the intervals between the first and second cutting of clover, or when they are engaged at hard work in harvest, or at other times.

In the northern parts of this country, farmers cannot generally begin to cut clover till the 1st of June; but in the southern part of the country, the soiling can be commenced much earlier. When there are many horses, one man may be employed to do the work of cutting and putting the cut forage in bunches, and it should be taken home by a spare horse, so as to be ready when the horses return from work. One man will put into bunches a quantity sufficient for 20 horses, and each horse will consume upon an average about 200 lb. in a day.

When the horses are turned out to the fields at night, and kept on cut forage during the day, they should be put into their stables by the beginning of September, and kept in the house during the night, receiving green forage if it is yet upon the farm, or else receiving hay. By the 1st of October they should generally be put upon hay and corn.

This, then, forms the circle of feeding of the horses of the farm:—They are put on hard food by the beginning of October, receiving hay and a medium allowance of oats. In the months of November, December, and January, their hay is withdrawn, and they are put on straw, receiving a moderate allowance of oats. In February, they are again put on hay, with a full allowance of oats, until about the commencement of June, when they are put on green food, with a lessened allowance of oats, and either fed entirely on cut forage, or pastured during the night, receiving cut forage during the intervals of work in the day.

In the practice of feeding farm-horses, the utmost care must be taken that they never be allowed to get out of condition. In this case, not only are they unable to perform their work, but it requires a much greater expense to bring them again into order, than it would have required to keep them so.

In feeding horses, even when upon hard work, a practice has been introduced of feeding the horses entirely on boiled or steamed food, with chopped hay and straw. The proportions of the different kinds of food employed in this manner are not subject to rule. But about ¼ in weight of the whole may consist of the chaff of straw, ¼ of the chaff of hay, ¼ of bruised or coarsely ground grain, and ¼ may consist of steamed potatoes. To this should be added about 2 oz. of common salt. From 30 to 35 lb. of this mixed provender, or on an average 32½ lb. in 24 hours, will suffice for any horse.

Two methods may be adopted in the giving of this food. Either the whole substances may be mixed together, and a certain proportion given to the horses three or four times in the day, or the dried food alone may be given during the first part of the day, and the steamed food mixed with a portion of the dried food in a mess at night.

In the first case, that is, when the whole mess is to be mixed together, the potatoes or other steamed food are first to be prepared, then weighed and mixed with the chopped straw or hay, and with the bruised oats. The quantity for 24 hours being mixed and prepared, the proportion for each horse is to be weighed and set apart in its proper pail, and given to each horse at three or more times, as shall best suit with the work with which he is engaged, taking care that considerably the largest quantity shall be given at night.

When this method of feeding is adopted upon a farm, it should be confined entirely to the months of winter, for the horses of a farm will always be best and most economically fed during the months of summer on pasture and green forage.

From the mixed nature of our husbandry, the habits of the people, and the attention paid to the rearing of the horse, a long and general preference has been given to this animal for the labours of the farm. In certain districts of England the ox is still the more common beast of labour; but in by much the greater number, the ox is either unknown as an animal of draught, or employed only partially as an assistant.

The ox is a less expensive animal to rear to the age of labour than the horse; his subsequent cost of maintenance is smaller: he requires less care and attendance, and he is less subject to accidents and diseases. He has this further advantage over the horse, that, at a certain age, when unfit for labour, he can be fattened, whereas the horse declines after a time, and becomes useless. But the ox, though well suited for a slow and steady draught, such as the plough demands, is not so well adapted for active motion or distant carriages as the horse. Although patient of labour, he sinks under extreme fatigue, and is not capable of those sudden exertions which the diversified operations of our agriculture require. The horse therefore, which unites force of draught with quick action, facility of travelling, and the power of bearing great fatigue, is in these respects better suited than the ox to the varied labours of an extended farm. As agriculture, accordingly, has improved, the use of oxen has given place to that of horses for the common purposes of the farm.

Being thus employed as the principal or only animal of draught on farms of this country, being in universal demand for carriages of every kind, and for the innumerable purposes to which he is adapted, the breeding and rearing of the horse form an important branch in the rural economy of this island.

The demand for horses for the saddle, for the lighter and more rapid carriages, and for the heavier labours of every kind, is exceedingly great. The vast supply required is furnished by the land of the country. Either the farmer directly rears the animals, or he raises the food by which another class of traders is enabled to rear them. The greater number of horses is produced on the farms of the country, and they consume the produce upon the ground until they are of an age to be used. The exceptions are the cases of those particular kinds of horses, as the race-horse and the finer animals for the saddle, that demand an especial attention.

II. THE OX.

1. SPECIES AND VARIETIES.

Of the ox kind 8 species are enumerated by zoologists—

1. Bos urus—The Aurochs, the Bison of the ancients.
2. Bos bison—The Bison, or Buffalo of America.
3. Bos moschatus—The Musk Ox.
4. Bos frontalis—The Gayal.
5. Bos grunniens—The Grunting Ox.
6. Bos caffer—The Cape Buffalo.
7. Bos bubalus—The Common Buffalo.
8. Bos taurus—The Domestic Ox.

Of these species, the Aurochs, the Bison of America, the Musk Ox, and the Cape Buffalo, have not been domesticated. The Gayal and the Grunting Ox are both cultivated in Asia but have not been introduced into Europe, in which the only species reared are the common Buffalo and the Domestic Ox.

The Common Buffalo, a native of the warmer regions, has come to us beyond a question from Eastern Asia. He seems to have been introduced into Italy about the sixth century, and is now an important animal in the rural economy of that country. He is used by the Italians as food, and as the beast of labour, and may be said to form the riches of the inhabitants in many parts of the country. He is cultivated, too, in Greece and Hungary. He prefers moisture and the rank herbage of marshes. The milk of the female is good, but the flesh is held in less esteem than that of the common ox. The pace of the animal is sluggish, but from the low manner in which he carries his head, throwing the weight of his great body forward when pulling, he is well suited for heavy draught. But this is not a property sufficiently important to cause the introduction of the buffalo into the agriculture of Northern Europe, and he is not likely, therefore, to be carried beyond the countries where he is now reared.

Of all the species the Domestic Ox is the most generally diffused, and the most valuable. He has existed in a domesticated state beyond all the records of history and tradition, and naturalists can but conjecture from what parent-stock he has been derived. Like all the animals necessary to the subsistence of man, he suits himself in a wonderful degree to the circumstances in which he is placed. Where food is scanty, he scarce exceeds the size of the deer, but where it is abundant, he reaches to enormous size. He is found from the equator almost to the limits of vegetable life, and is every where subservient to the wants and conveniences of the human races.

The female is in a remarkable degree subordinate to the interests of mankind; she is every where docile, patient, and humble. Milk, which forms so nutritive an aliment for the human species, is yielded by her with an abundance and facility unknown in the case of any other animal. She has a more capacious udder, and larger mammæ, than any creature known to us. She has four teats, although she gives birth to but one young. Like the sheep and goat she yields milk freely to the hand, although far more abundantly; whilst many other animals refuse their milk, unless their own young, or some other animal, be allowed to partake of it by sucking them.

From the earliest times Great Britain has been remarkable for the excellence and numbers of her sheep and oxen, and owes no little part of her opulence to this cause. The varieties of those animals are greatly diversified, both by the different natural circumstances in which they are placed, and by the effects of art in changing their properties and form. To these varieties is usually applied the term *breeds*.

The main divisions of breeds of oxen in this country is into those of the mountains and those of the plains.

Of the breeds of the mountains, the most characteristic and numerous are those of the Highlands of Scotland. These animals, although differing in size and useful properties, are, with the exception of those inhabiting some of the northern islands, united by certain characters, which bring them under the common denomination of a breed. Their general character is that of a small and hardy race, adapted to a country of heaths and high mountains. The best and largest are those which are produced in Argyleshire and the Hebrides, which may be traced to the superior herbage and milder climate of the western coast; and in certain cases to the greater care bestowed on breeding. In the more steril parts of the Northern Highlands they are of smaller size and less perfect form.

In the Zetland Islands there exists a peculiar race, probably derived from the north of Europe. The Zetland oxen, when pure, are of good form; but they have been greatly injured by crossing. Their horns are short, and their skin soft; their flesh is finely marbled, in this respect equalling that of any of our breeds of cattle. The females are better milkers than alpine cows generally are, and are remarkable for the early period at which they arrive at maturity and receive the male. They afford admirable first crosses with superior males, as with the short-horns.

The cattle of all the Highlands of Scotland are reared in vast numbers, and brought at different ages to the Lowlands, where they are fattened for the supply of the various markets of consumption throughout the country. In this manner they are spread over every part of the kingdom, and are held in general estimation for their hardy properties, and the goodness of their flesh. No race of cattle can be better suited to the physical circumstances of the country in which it is reared than this hardy mountain race ; and what is to be desired with respect to its improvement, is not a change of breed, but judgment in rearing from the same breed, so that the individuals may be brought to the greatest perfection in size and disposition to fatten, which the circumstances of the country will allow.

The oxen in Wales have, in like manner, the characters which might be expected in a country of mountains ; but they are of various size and aspect, dependent upon the productiveness of the pastures, the care with which they have been treated, or their more or less intermixture with stranger blood. The Pembroke cattle may be regarded as the type of the mountain breeds of Wales. Their size is nearly the same as that of the West Highlanders, which they resemble in their general characters ; and both races have an affinity with the ancient wild cattle which seem to have been spread over a great part of this country when covered with wood, and of which the remnants are yet preserved in a few places, as at Chillingham and Lanark. Another breed of Wales is the Glamorgan, which, however, is to be classed with the larger breeds of the lower country, rather than with those of the mountains. The improved Glamorgan is a valuable breed, of good form and fattening properties. The oxen are well adapted to labour ; the cows are suited to the dairy.

In Ireland the varieties of cattle are very great. Of those proper to the mountains one is the Kerry breed, the cows of which are largely spread over Ireland, and esteemed for their hardiness, and fitness for the domestic dairy.

Of the larger breeds of the lower country, the first to be mentioned is the Long-horned. This variety extends over the plains of Ireland and the western parts of England, and was once the most generally diffused of the larger races. The individuals are distinguished by the length of their horns, and frequently by their bending downward. It is frequently termed the Lancashire breed, from its having been the prevailing one of that county; but it extended in great numbers northwards through Cumberland and Westmoreland, eastwards into Yorkshire, and southwards to Leicestershire, Warwickshire, and others of the midland, and even the southern counties. In Yorkshire the district of Craven, lying on the confines of Lancashire, was long celebrated for its breed of long-horns, and afforded bulls to other parts of the country. In the earlier part of the last century, Mr Webster of Canley, in the county of Warwick, was a distinguished breeder of this variety. His stock obtained the name of the Canley breed, and maintained its reputation for a considerable period. But to the Canley breed, and partly derived from it, succeeded the Dishley breed, so named from Robert Bakewell of Dishley, in the county of Leicester, who, soon after the middle of the last century, began those improvements in live-stock, which exercised so great an influence, not only on the long-horned breed of cattle, but on all the races of the domesticated animals of this country. Mr Bakewell chose, as the basis of his intended improvements, the long-horned breed as it then existed; and, by long perseverance and skilful experiment, communicated to it the properties required of early maturity and disposition to fatten. The precise steps which he followed in the course of his experiments are unknown. It has been supposed by some that he crossed the native long-horns with some other variety. This, however, is in no degree supported by an examination of the breed which he produced, which is the long-horned in all its essential characters, and evidently derived from the pre-existing stock.

The older race of long-horns, and great numbers yet remain with the same characters, were distinguished by the thickness of their skins, by the length of their hair, by the largeness of their hoofs, and by a general heaviness of form. They were deep in the fore-quarters, and comparatively light in the hind-quarters. They weighed well in proportion to their size. Their milk, though not large in quantity, was rich in cream, and hence they were not unsuited to the dairy. They were of all colours, but had usually a streak of white along the back. They were hardy, docile, and by these properties suited to heavy labour. From the thickness of their hides, and the length of their hair, they were well adapted to feeding in a moist climate, and on ordinary pastures.

The labours of Bakewell, and of others who pursued the same course of improvement, removed the main defects of the older breed of long-horns. But although the improved breed possessed many excellent qualities, it has not maintained its place in public favour. The individuals, indeed, are kindly feeders, and do not require peculiar nicety of treatment; but the quality of the flesh is inferior, the fat accumulates too much on the posterior parts, and the females are bad milkers. For these reasons chiefly, the Dishley breed has lost the favour with which it was once received, even in the districts where it was most cultivated. Bulls, however, still continue to be exported to Ireland by a few breeders who have kept up the purity of the ancient stock.

The next to be mentioned of the larger breeds is distinguished from the last by the general form of the animals, and by the size and position of their horns. They are termed the Short-horned breed, although the character derived from their horns does not alone distinguish them from other varieties. They are believed to be derived from Holland or Holstein.

The true districts of the short-horns, are the counties of Durham, York, and Lincoln, though in the latter county the variety assumes a coarser form. The counties of York and Durham had been in an especial degree long noted for the attention paid to live-stock of every kind; and the district upon the Tees, the river separating these two counties had been in an especial degree distinguished.

This variety came to be distinguished as the Teeswater breed, which name it still retains.

During the last century, various individuals distinguished themselves as breeders of the Teeswater short-horns. At a period comparatively recent, Messrs Charles and Robert Colling of Darlington, in the county of Durham, proceeded with yet more success to complete the improvement of the breed. By judicious and happy selection, the former of these gentlemen did for the short-horns what Mr Bakewell long before had done for the long-horns. But his improvements were made on a better basis, and the result was a superior race of cattle. It was not, however, till about the year 1800, that the reputation of the improved variety was fully established, and that it began to supersede other breeds in every part of the country. It received very generally the name of the Durham breed, and the animals are familiarly known by the name of Durhams.

The short-horned differs from the long-horned breed in the more square and massy form of the animals. Their skins are thinner, their hair more short, and generally they attain to a greater size. The quality of their flesh is superior to that of the long-horned, and the females are better milkers.

But, besides the more highly improved variety of short-horns, there are large classes of animals of the name which remain either without intermixture, or with a partial one, with the blood of the recent breed. Of this class are many of the Holderness cattle, so named from the district of Yorkshire where they are reared. They are a large race, resembling in their characters the Teeswater previous to the improvement of Colling. They are of sound constitutions, not unapt to fatten, and are in the first rank of dairy cows of this country. But generally, the Holderness have been more or less crossed by the Durhams.

A similar class of short-horns is proper to the adjoining fens of Lincolnshire. These, in the language of Smithfield, are termed Lincolns. They have been long noted as a large coarse race of oxen. But the interest of breeders has almost universally led them to diminish the size and increase the fattening properties of the animals, by a mixture with the blood of the more cultivated kinds. The Lincolns, like the Teeswater, have frequently received the name of the Dutch breed, evincing the universal traditionary opinion as to their origin.

There are thus two breeds of cattle in this country, both breeds of the plains, and very greatly distinguished from one another. The Lancashire, or long-horned, brought to perfection by Bakewell, and the short-horned, or Teeswater, brought to perfection by Charles Colling.

The next to be mentioned of the larger breeds is the Hereford. This race is proper to the rich district of old red-sandstone, which comprehends the county of Hereford. An affinity is usually endeavoured to be traced between the Hereford and the Devon. This affinity, however, is by no means striking in the modern Herefords. But whatever be the early history of the Hereford breed, it has long acquired characters peculiar to itself, and ranks as a distinct breed. The Hereford, however, owes its celebrity to recent changes. Its great improver, or rather it may be said the founder of the modern breed, was the late Mr Tomkins, Kingspion, near Hereford. From a very humble stock of cows, by changes or crosses which he never chose to reveal, Mr Tomkins formed the beautiful breed from which the modern Hereford takes all its characters.

The Herefords are of the larger class of oxen. They are of a red colour, with white faces, and more or less of white on other parts. The tendency of modern breeders has been to breed more to the white colour of the stock. The Herefords are of high estimation amongst the breeders of England, wherever they prevail. The quality of the flesh is good, and on this account it is much valued in the markets of Bath and London. The females are small as compared with the size to which the oxen reach, a character likewise possessed by the Devons. They partake, too, of the character of the Devon and other allied breeds, in being bad milkers, on which account the Herefords are exceedingly ill suited to the purposes of the dairy. Although of a less agile form than the Devons, their steady strength, combined with a sufficient degree of activity, suits them well for the draught. On comparing them with the short-horns, the principal superiority of the latter which strikes the eye, is the larger size from the hook-bone backwards, and the greater depth of the hinder quarters. The Herefords excel the short-horned in the shoulder.

The Devon forms a beautiful and peculiar variety, proper to the district which extends from the Bristol Channel through the high lands of Devonshire. They may be said to be of a family which is widely diffused, since cattle of very similar characters are found on the banks of the Don and elsewhere. In England they are in their state of greatest purity in the district of North Devon, but extend with some change of character to South Devon, and the adjoining districts. Their skin is of an orange-yellow, and they are distinguished by their hair of bright red, and by their eyes being surrounded by an orange-yellow ring of the colour of the skin. They are more allied to the lighter breeds of elevated countries than to the larger breeds of the plains. Their general form is light and graceful. Their skins are soft, their horns of medium length, very fine, and bending rather upwards. They are gentle, active, and above all our oxen suited to active labour, from the lightness of their form. The cows are small, as compared with the oxen, and like the females of Alpine breeds, they are deficient in their power of yielding milk. The South Devons are of larger size, and less symmetrical form.

Of the same characters as the Devon, is the Sussex breed; but the individuals are of larger size and coarser form. They have not been cultivated with the same attention to purity of blood as the North Devons; though the exertions of particular breeders have shown them to be susceptible of a high degree of improvement. They are nearly as active in the plough as the Devons, with a greater weight of body. They are not of such uniform colour as the Devons, being frequently marked with white.

Minor varieties might be traced to an affinity with the mountain breeds on the one hand, or the long-horned, the short-horned, or the Devon, on the other. Some of them are distinguished by being destitute of horns. Circumstances of soil and herbage may doubtless give rise to this peculiarity, in the same manner as to colour and other minor characters; but, in general, the prevalence of this character in particular districts may be ascribed to the choice, by breeders, of such individuals as have no horns, and to their breeding from these until the peculiarity comes at last to be confirmed in the breed.

Of the polled breeds of England, the most remarkable is the Suffolk Dun. These cattle extend, but more or less modified in their character and form, to the counties of Norfolk, Suffolk, Cambridge, and Essex. The prevailing colour used to be a mouse-dun, and thence their distinctive name; but they are now of many various colours. They are hardy, and good milkers, but have only in the hands of a few breeders been brought to any considerable perfection of form. They bear some resemblance to the Galloway cattle of Scotland, and it has been supposed that they are a variety of that breed produced by the long intercourse between the Scottish drovers and the Suffolk and Norfolk feeders. It is probable, at least, that this circumstance has given a character to the native breed. They are termed home-breds in the market of Smithfield.

The Galloway breed is proper to the mountainous tract of the south-west of Scotland, forming the high land of the counties of Wigton, Kirkcudbright, and Dumfries. In size and characters the Galloways are a mountain breed. They are distinguished by the peculiarity of being destitute of horns. They are indifferent milkers, though yielding good cream, in which respect they resemble the long-horns. They are well suited to the pastures and moist climate of the districts in which they are reared. They are hardy, docile, and good feeders. Large numbers of them are sent annually to Norfolk, and being fattened in the English pastures, supply the markets of the districts, or are carried to Smithfield, where they are known and greatly valued. This breed being adapted to the nature of the district, and the state of its agriculture, every care should be bestowed in increasing its good properties, by selection of the best individuals of the same race. The breed has suffered from want of attention, and in some cases has been injured by injudicious crossing; but the attention of the Galloway breeders, it is to be believed, will now be kept alive to the expediency of preserving and improving this staple production of the district.

The breeds of Scotland to the north of the Frith of Forth, are more or less allied to the parent stock of the mountains, but with characters modified by the physical circumstances of the districts in which they have been naturalized.

On the lower parts of Aberdeenshire and other northern counties on the coast, the breed is essentially that of the Highlands, but of larger size, from the more favourable circumstances of the country in which it is cultivated, and in a few cases by the effects of partial crossing. The best of these cattle were supposed to be the hornless breed of the northern part of Aberdeenshire, termed the Buchan breed, which is now scarcely to be found pure. The horned Aberdeenshire forms a coarser race of animals, and is now losing favour.

In the county of Forfar there has long existed a distinctly marked variety, to which has been given the name of the Angus breed. It is proper to the red sandstone district which constitutes the plains and less elevated parts of Forfarshire. The individuals resemble the Galloway in size, in general aspect, and in the peculiarity of being destitute of horns, and there can be no doubt that crosses with the Galloways have produced this resemblance. They have thinner skins, and less hair than the Galloways; their bodies are less deep, and they rarely possess the fineness of rib which distinguishes the southern breed. The modern Angus, however, is assuming an almost new character, by the care and skill bestowed on its improvement by some distinguished breeders.

The cattle of Fifeshire are much mixed; yet a considerable proportion possesses such characters as to indicate a common parentage. They are generally of a coarse defective form; but they are hardy, and the females are good milkers. Tradition refers to early importations into Fifeshire of cattle from other parts. The Falkland breed, so called from the royal palace of that name, is believed to have been the result of one of those importations of cattle made during the occasional residence there of one of the kings of Scotland. However this be, the Falkland breed appears to have been distinguished by characters of its own, and to have communicated these characters more or less to the cattle of the adjoining district. This fine variety has been unfortunately nearly lost in its state of purity. Where individuals remain whose characters enable us to trace them to it, they show great resemblance to the black dairy cows of Holland; from which it appears probable that the old Falkland breed of Fifeshire was of Dutch, and not, as is commonly supposed, of English origin.

To the south of the Frith of Forth, the short-horns are established, particularly in the south-eastern border counties, where they have been long cultivated with care. On the western coast, and extending inland, is a breed, the Ayrshire, which presents peculiar characters.

This breed, deriving its name from Ayrshire, extends to the adjoining counties of Lanark, Dumfries, Renfrew, Dumbarton, and elsewhere. It manifests certain points of resemblance to varieties of the short-horned breed; but all its essential characters of form connect it with the Alderney. The resemblance is so great that a Jersey cow might sometimes be mistaken for an Ayrshire one. The cows of the district of Dunlop are said to have been the first celebrated for yielding milk; and tradition asserts that the cows of that district were crossed by Alderney bulls. This, then, may be inferred to be the true origin of the dairy breed of Ayrshire; but it is probable that males of the Holderness or Dutch breed have been also introduced, and given certain characters to the native stock, though at what time such intermixtures took place, or how far they affected the characters of the existing stock, is unknown.

The Ayrshire, as now cultivated and improved, is well defined in its characters: The animals are delicate in their horns and limbs, their fore-heads are narrow, their shoulders thin, and their fore-quarters light. This is a form which is valued in the female as indicating a disposition to secrete milk; but it does not correspond with the form of an animal which indicates a disposition to grow to a great size, and feed readily. It is, however, as a dairy breed that the Ayrshire is to be regarded; and by the attention of the breeders to the characters required, they have succeeded in producing a breed exceedingly well suited to the purposes of the dairy.

The farmers of the West of Scotland set a high value upon this breed, and they do so with reason. For a main object with them being the dairy, the breed is well suited to this purpose. But where the principal end is feeding, the Ayrshire must be held as occupying a secondary place in the breeds of this country. They fall short of the Devon, of the Sussex, and yet more of the Herefords and the short-horns.

The breed termed the Alderney, is cultivated in the Islands of the Channel. Of this race the finest are supposed to be produced in the Island of Jersey, where they form the riches of the inhabitants, and are attended to with extreme care. They are small and ill shaped, when regarded as feeding animals. Their skin is of a rich orange-yellow; and the fat as well as the milk and butter partake of this colour. They are highly valued for the dairy, but are rather to be esteemed for the fine quality of the milk than for its abundance. The purity of the breed, in Jersey, has been preserved by jealous laws, prohibiting the introduction of foreign animals. Great numbers of the cows are exported to England, and insensible crosses have thus been produced which are to be traced in the English dairies.

It is not necessary to enumerate further the minor varieties of cattle to which the term breeds may be applied. Those with which the principal races of the country are more or less allied, may be said to be,—

1. *The Mountain breeds*, comprehending those which are naturalized, and reared in the more elevated parts of Scotland, Ireland, and Wales.

2. *The Long-horned breed*, prevailing chiefly in the western

parts of England, and the plains of Ireland, and of which the most approved variety is the Dishley.

3. *The Short-horned breed,* more peculiarly belonging to the eastern parts of the country, and of which the most improved variety is the Durham.

4. *The Devon,* peculiar to the south of England, to which is allied the Sussex, and by a more remote affinity, the Hereford.

5. *The Alderney,* peculiar to the Islands in the British Channel.

2. IMPROVEMENT OF BREEDS.

The breed must be adapted to the means, natural or acquired, possessed of supplying food. Art and an improved system of tillage do much in supplying the food of herbivorous animals. By cultivation we can change the nature, and increase the abundance, of the food supplied. But in many cases, tillage is only practicable or expedient to a limited degree, and then the natural pastures of the country must furnish the main supplies of food. In a mountainous country, where the principal food is natural herbage, and where the means do not exist of obtaining artificial food, it would be vain to attempt the rearing of a large and fine breed of oxen. We must, in such a case, be satisfied to rear a race, of hardy properties, of small size, and capable of subsisting on coarse herbage.

Where, again, art or the natural fertility of a country admits of supplying sufficient food, the study of the breeder should be to select a race of animals, the best that circumstances will allow him to rear.

Having fixed on the kind of breed which is the best suited to the circumstances of the district or farm, the practical question to be determined, is the manner in which a proper breed should be obtained, or the old one improved. There are three methods which may be adopted for this purpose :—

1. The entire change of the existing stock, and the substitution of a different breed, females as well as males.

2. The retaining of the old breed, male and female, and improving them by breeding from the best animals of the same breed.

3. The improving of the breed by crossing with males of a different breed.

When the nature of a farm allows, the most speedy and the best method certainly of attaining the end is to change the stock, and to substitute females of the improved one from which it is proposed to breed. In this manner the purpose will be effected at once, without the labour or loss of time of improving a defective stock.

The second method is the retaining of the existing stock, and improving it by a selection of the best individuals of the same breed. This is the method which ought to be adopted if the breed already existing is sufficiently suited to the natural circumstances of the farm, and to the method of cultivation which can be pursued upon it.

The third method is that of crossing, that is, the retaining of the females, and the employing of males of a different breed. This method has often led to disappointment, from the nature of the crosses attempted, especially where the crosses have been violent, as between animals of very different characters. The first cross in general will be good, but in breeding from the progeny of this cross, expectation will often be disappointed. Not only do the good qualities of the first cross not always remain in the progeny, but often there are found in it defects which cannot be traced to the parents.

This, however, generally arises from injudicious crossing, and from unacquaintance with the principle on which the crosses of different animals should be conducted. When a cross is made, it should be with a male of a superior breed; and in this case the first cross will be almost always a good animal. To secure the full benefits of the cross, however, we should not too hastily resort to the males of the inferior stock, because it might be found, that, while we had injured the original breed, we had not substituted a better in its stead. The general rule, therefore, should be, to cover again the first cross with a superior male of the same breed, and so on, until the good character of that breed became permanent in the progeny. This is said to be breeding up to the superior stock.

In crossing, the essential characters of form are imprinted on the offspring by the male; and it is surprising in how great a degree this imprinting of better characters takes place, when a male of superior breeding is employed. A first cross between a short-horned bull, for example, fully bred, and a very ordinary cow, produces, not only often, but generally, a fine animal, with an extraordinary aptitude to fatten. Many of the very fat animals that receive premiums at the cattle-shows in this country, are extreme crosses of this kind. But the benefit may end with the progeny, if we do not again cover with a male of the same superior breed, and so on until the good characters become permanent.

When a breeder, then, is to improve his stock by crossing, he ought to select a male of undoubtedly superior blood. And he should not generally, after the first cross, resort to the males of the inferior breed, but to those of the superior one, until he has formed, as it were, a breed for himself. There are, indeed, numerous cases in which a single mixture of better blood will do good, as with those inferior breeds which have no fixed characters. These will be improved by even the slightest intermixture with the blood of a better race; and a farmer who is in a district where this class of animals prevails, may safely avail himself of a good male, in the same manner as a breeder of horses would do, although the stallion were of a different character from the native stock. The cases where crossing of any kind is to be attempted with caution, are, when a breed of established good characters, or of characters which fit it for the nature of the country and the state of its agriculture, already exists.

In crossing, then, the rule is, to breed from a male of superior stock; and, fortunately, in this country we have now a breed of such established character, that no mistake can arise in the selection of males. These have been formed to our hand, with all the care that art can bestow in improving the form of fattening animals. There is no need, therefore, for those mistaken attempts at crosses which were sometimes made with males of questionable characters, as between an Ayrshire cow and a Galloway bull, and *vice versâ.* We can predicate nothing securely of the progeny of such crosses as these, the effect of which will probably be to destroy the good properties of either breed, as the aptitude to yield milk of the Ayrshire, and the hardy and feeding qualities of the Galloway. But in crossing with a breed so highly cultivated as the short-horned, the breeder has the assurance that he will produce animals of large size and good fattening properties. He is to consider, indeed, whether he has the means at his command of rearing the larger animals; and if this be so, it will be better that he at once form his stock upon the best model, than run the hazard of wasting time and capital on questionable crosses.

And it must be regarded as highly important as a mean of improving the live-stock of Great Britain, that a breed has been formed, by long-continued selection and care, which may always be resorted to, to effect the purposes required, in the same manner as recourse is had to horses of known pedigree, to communicate their characters to the progeny. In this manner the labours of those who have improved the short-horned breed, have extended far beyond what the original breeders contemplated. They have not only improved a peculiar breed, but have furnished the most efficient means that can be used of improving the live-stock of the entire country; and it is to be trusted that the breeders of this class of animals will have encouragement to maintain the characters of the breed with as much care as is used in the case of the race-horse, seeing that it is for a far more important end.

But having selected the breed, or having fixed on the means to be employed for forming it, a point to be determined is the manner of maintaining or improving it, by the selection of good individuals, male and female; for it is to be observed, that it is equally determined, in the case of the ox as of the horse, that the properties of the parents are conveyed to the offspring. The male undoubtedly acts the principal part in impressing his characters on the young. But the form of the female is of the utmost importance; and if we hope to arrive at success in breeding, the form and characters of the female must be no more neglected than those of the male.

Now we might breed either from animals nearly allied to one another in blood, as brothers and sisters, parents and their offspring, technically termed breeding in-and-in, or from animals of different families. By the latter method are produced animals more hardy and less subject to disease; by the former, we are frequently enabled to produce animals of more delicate form, and greater fattening properties, and above all to give a greater permanence to the characters of the parents in the offspring. It is known that Bakewell and other breeders were enabled, by this system, to give and perpetuate the peculiar characters of their stock. These first improvers, indeed, found the practice to be, to a certain extent, necessary, because they could not resort to the males of other families, without employing inferior animals, and so impairing the properties of their own breed.

It is to be observed, that the breeding and continuing to breed from animals very near of blood, produces animals which have a greater tendency to arrive at maturity, and to become fat. This seems to result from a tendency to premature age in the animal, which thus more quickly arrives at its maturity of bone and muscle, and so begins sooner to secrete fat.

The system, however, of breeding from animals near of blood, has its limits. Nature will not be forced too far for our purposes. It is known that, although this joining of animals closely allied diminishes the size of the bones, and gives a tendency to fatten to the progeny, it renders them also more delicate and subject to diseases. Although, then, this near breeding may be carried to a limited extent between very fine animals, for the purpose of rendering their qualities permanent in the offspring, we do a violence to nature when we carry it too far. The progeny, along with their early maturity and aptitude to fatten, become feeble; the cows cease to secrete milk in sufficient quantity to nourish their young; and the males lose their masculine characters, and become incapable of propagating their race.

When, therefore, the stock of any farmer has become too nearly allied, he ought not to fail to change his males, and procure the best of the same breed. This is essential to preserve the health of the stock for any time. Great losses have been sustained by breeders who have carried the system of close breeding too far, with the design of pushing the improvement of their breed to its limits.

A character of a breed not to be neglected, is size of the individuals. Although large animals consume more food than small animals of the same species, yet they do not consume food in proportion to their greater size; and hence the benefit of rearing the larger animals, if the natural or acquired productiveness of the farm will allow it. But although size be an important element in the character of a breed, there is another property to which that of size is subordinate, namely, that of a disposition to quick fattening and early maturity. This property depends not on size, but on a different class of characters.

3. Form.

The principal purpose in rearing oxen in this country, is to produce flesh. The rearing of females for milk is, doubtless, also important; but in the great majority of cases, this purpose is regarded as subsidiary and subordinate to that of feeding.

There are certain external characters which indicate a disposition in the animal to become fat, and certain characters that show that the animal has less of this property, and does not quickly arrive at maturity. These characters are familiar to breeders, and a knowledge of them is readily acquired by practice and observation. But before attending to these characters, it will be well to consider in what really consists the property of quick and easy fattening.

The flesh of an animal, it has been said, consists of muscles. A muscle is a combination of threads or fibres, bound together by a sort of minute mesh-work, to which the term cellular tissue has been applied. Each thread or fibre is divided, so far as the eye assisted by powerful glasses can discover, into smaller fibres still. A number of these smaller fibres or filaments forms a fibre; a number of these fibres forms a fasciculus, or bundle of fibres; and a number of these fasciculi forms a muscle. Now, surrounding the fibres, the fasciculi, and the muscles, is the unctuous substance, fat. The same matter is formed between the muscular substance and the skin, and surrounds, or is intermingled with, the various viscera within the body. It surrounds, in large quantity, the heart, the kidneys, and other organs.

The muscular fibre grows with the animal, and is essential to its existence and power of motion. When the animal arrives at its full growth, little further addition can be made to the muscle; but it is otherwise with the growth of fatty matter. When the food which the animal assimilates by the action of its organs, is no longer needed to be converted into muscle, it is converted into fat, and this being intermingled with and surrounding the fibres, the fasciculi, and the muscles, the muscle becomes enlarged. By feeding an animal, then, we have little power over any increase of the muscular substance, but we have a great one over the fatty substance, which, along with the muscle, forms food.

Now, an animal that arrives soon at maturity with regard to the growth of his fleshy fibre, and tends readily to secrete fat, is the kind of animal best suited to the purposes of the breeder and feeder. Such an animal is said to be a quick grower, and kindly feeder.

These properties seem mainly to depend on the power of digestion possessed by the animal. And the external characters which indicate this are a capacity of chest for containing the respiratory organs, and of trunk for containing the stomach, and other viscera employed in the process of digestion. This we may infer from the effect: for, in all cases, it is found that the property of quick fattening is combined with a capacious chest and a round body. An animal of this form requires a less quantity of food to produce a given increase of weight, than one whose chest is narrow and whose sides are flat. When we look for a fattening animal, therefore, we require that his chest shall be broad, and his ribs well arched; and where this form exists, the back will likewise be wide and flat. We require, too, that the body shall be large in proportion to the limbs, or, in other words, that the limbs shall be short in proportion to the body.

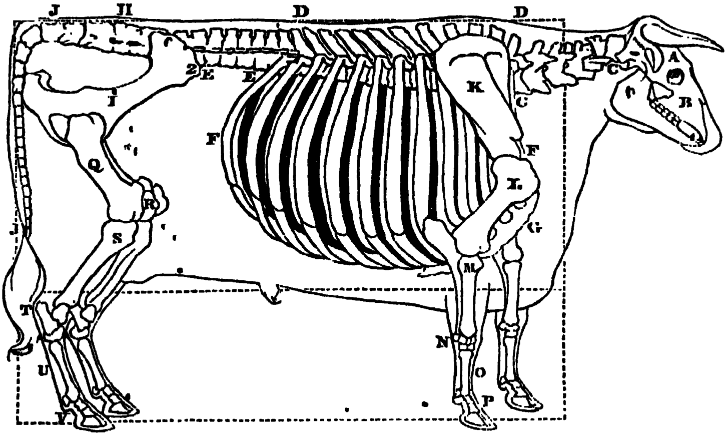
Further, it is seen, that, in animals indicating a disposition to fatten, there is a general rotundity of form,—as where the neck joins the head, the shoulders, the neck, and so on,—and that there is a general fineness or smallness of the bones, as of the limbs and head. The limbs being short, the neck is not required to be long, and shortness of the neck, therefore, is a character connected with a disposition to fatten.

In the case of the horse, it was seen that the body abstracted from the neck and head is comprehended within a square, the body occupying about the half of the square. But, in the case of the ox, the body is comprehended within a rectangle, as in the following figure, and the body occupies more than the half of the rectangle.

In the one case, there is the outline of an animal fitted for speed; in the other, of an animal with great bulk of body, and unfitted for active motion. The horse, which occupied too much of the square, would be regarded as of bad form. In the ox, the more of the rectangle which the body occupies, the more does the form approach to that required by the breeder.

The tendency to early growth and kindly feeding is likewise indicated by the touch. This property is known to graziers and breeders, who are all familiar with the soft and delicate feel of a good animal. They call it a mellow feel, the meaning of which it is more easy to conceive than define. It is a certain softness combined with elasticity of the skin. The difference between the skin of a coarse animal and one possessing the peculiar softness here referred to, can, by a little practice, be easily discriminated.

Fig. 185.



CC	Cervical Vertebræ.
DD	Dorsal Vertebræ.
EE	Lumbar Vertebræ.
A	Bones of the Cranium.
B	Bones of the Face.
II	Sacrum or Rump-bone.
JJ	Bones of the Tail.
FF	Ribs.
G	Sternum or Breast-bone.
I	Bone of the Pelvis.
Q	Os Femoris—Thigh-bone.
R	Patella—Stifle-bone.
S	Bones of the Leg.
T	Tarsal Bones, or Bones of the Hock.
U	Metatarsal Bones of the Leg.
V	Phalangeal Bones, or Bones of the Foot.
K	Scapula—Shoulder-blade.
L	Humerus.
M	Fore-arm.
N	Carpal Bones.
O	Metacarpal Bones.
P	Phalangeal Bones.
2.	Hip-bone, Huckle or Hook-bone.

The same characters which indicate a disposition to fatten in the ox, indicate it in the other domesticated animals. The fineness of the bones,—the largeness of the body as compared with the limbs, neck, and head,—the broadness of the chest,—the roundness of the body,—and the soft and elastic touch,—indicate in all cases this property.*

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* The following are several of the popular characters which are generally given as indicating the fattening powers of the ox :—1. The head should be fine and tapering to the muzzle, which should be thin. 2. The neck should be free from coarseness, large where attached to the shoulder, and tapering to where it joins the head. 3. The breast should be wide, and projecting

4. REARING AND FEEDING.

The period of gestation of the cow is about 40 weeks, varying somewhat according to the constitution of the animal. She is sometimes capable of receiving the male during her first year, but he should not be admitted to her until after she has completed her second year.

Some time after having produced her young, the cow manifests a desire to receive the male. This continues for 48 hours or more, and returns at intervals of a fortnight or three weeks. When the male is admitted to her, she is generally at once impregnated. Should this not be so, the instinctive desire returns, and she must again be taken to the male until she has been impregnated, which is known by the ceasing of these periodical returns.

It is important to the breeder of feeding cattle that the calves should be borne early in the season, so as to afford the means of bringing them well forward upon the summer grass.

The proper season for calving is in the months of January, February, and March. When the period of producing the young has arrived, the cow has to be attended to with care, kept in the house, and the birth of the young waited for and assisted when necessary. The position of the fœtus is with the

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well in front of the fore-limbs. 4. The shoulder should be broad, but joining without abruptness to the neck before, and to the chine behind. 5. The back and loins should be straight, wide, and flat. 6. The girth behind the shoulders should be large: the ribs should be well arched, and the distance between the last rib and the hook-bone small. 7. The hook-bones should be far apart and nearly on a level with the back-bone: from the hook-bone to the rump the quarters should be long and straight. 8. The belly should not hang down; the flanks should be well filled up; the legs should be fleshy to the knee and hock, but below the joints they should be tendinous. The tail should be on a level with the back, broad at the top, and tapering to near the extremity. The hoofs should be small; the horns fine and pointed, and slightly attached to the head, the ears thin, the eyes prominent and lively.

head couched upon the fore-legs. When it is otherwise the birth is more difficult, and sometimes the calf must be turned into the proper position. This is done by the hand, the cow being laid on her side, and gently raised from behind by hoisting. But in general the parturition of the cow is easy.

The calf, on being born, is to be carried away and placed loose in a pen or crib with clean dry litter. The cow need not be suffered to touch or recognise her young, as this only tends to render her uneasy and distressed by the separation. The cow should then be milked and fed with some nourishing food. A sheaf of barley answers the purpose very well, and some nourishing gruel should also be given. An excellent food for some time previous to calving, and some time afterwards, is linseed boiled, or bruised oil-cake dissolved in warm water.

In mountainous countries the cow may be permitted to suckle her calf during the months of summer; and a practice similar to this is frequently adopted with the breeds of the plains. But where a good breed of cows exists, the young should at once be separated from the dam and fed from the pail. The first milk drawn from the cow is viscid, and is peculiarly fitted for the nourishment of the young; for which reason each calf should first be fed by the milk of its own dam.

The quantity of milk given to the young animal should be as much as it can consume, which will be found to be somewhat more than a wine gallon in the day. The quantity which it can consume, however, will gradually increase to 2 gallons more, or 3 gallons in all; and this feeding may be continued for 12 weeks, when the animal is to be put into the course of being weaned, and in one month more completely weaned. The milk given to the calf is new milk, that is, milk directly from the cow. The milk, however, may be economised, by employing substitutes to a limited extent, and, in this manner, the milk of one cow be made to rear more than one calf. The best substitutes are farinaceous food, as meal and porridge. Linseed or oil-cake can be given, by using a little of these dissolved in the milk, its nourishing properties may be increased to any degree required. The calf should be fed three times in the day, regularly at a fixed hour.

After twelve weeks, the use of new milk may be given up and skimmed milk substituted, making it lukewarm, and the quantity gradually lessened; and in the course of one month more, that is, in four months in all, the animal may be entirely weaned.

This indeed is more liberal feeding than is usually deemed necessary; yet it is a great error to stint animals in their food at this age, with the view of economising milk. It is from this cause that so many stunted animals are to be seen in the hands of breeders, that never afterwards attain to a good size, nor acquire a disposition to fatten.

During the period of feeding with milk, the animals will be taught by degrees to supply themselves with food. For this purpose, when the season is not sufficiently advanced, a bunch of sweet hay, or any green herbs, should be placed within reach of the animals; and a little salt may be given, which they will soon learn to lick, when placed beside them. If the weather allows, they may be turned into a yard for a few hours in the day, and after a time, when the weather becomes mild, into a little paddock containing sweet grass, housing them at first at night, until they shall be fully hardened to the air.

The males, when not intended for propagating, may be castrated when 30 days old. The operation is easily performed, by two incisions with a sharp knife. An analogous operation is sometimes performed upon the female, when she is intended for feeding; but the more approved practice is to preserve her entire.

The weaning of the calf, it has been said, may take place at the end of four months. The calf is then merely turned into good pasture during the remainder of the season, and fed like the other stock, and generally along with the cows or feeding oxen; and, as in the case of all growing animals, it should be allowed ample food.

The subsequent treatment of calves necessarily depends upon the nature of the farm, and the species of food which can be supplied. Where there is nothing but coarse pastures and inferior hay, and when no turnips or cultivated forage can be raised, then the stock of the farm must be suited to these circumstances.

The breeders in such cases are generally merely the rearers of the animals. These, when they have reached a certain age, are disposed of to another class of farmers, who have the means to feed them. A great proportion of the land of Britain and Ireland is better suited for breeding in this manner than for feeding; and a large exportation of animals takes place from all the breeding farms and districts to be fed elsewhere. The feeders purchase the cattle at such age as suits their purposes, and keep them on their farms for such a period as they find expedient. This is a division of labour in the breeding and feeding of live-stock perfectly natural, and in an eminent degree favourable to the interests of individuals and the country. It is in this manner that each district and farm is applied, with reference to the production of live-stock, to the purpose to which it is best adapted.

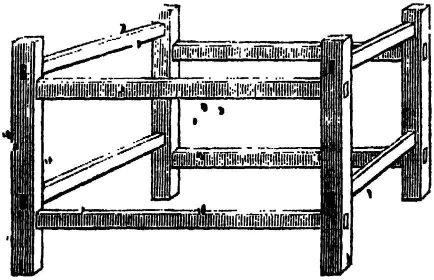
In cases where no other food can be supplied than the natural produce of the farm, the same care and delicacy in rearing are not necessary or practicable, as under a more artificial system of feeding. The cows, in such cases, are usually permitted to suckle their young. During the first winter, the young animals receive such pasture and natural hay as the farm affords. In the following summer they are kept on the coarse pastures of the farm; in the following winter they are maintained as in the former one, and so on until disposed of to the feeder, which may be in the second or third, or even sometimes the fourth, year of their age. The sooner cattle, under these circumstances, can be brought to maturity, the better is it for the interests of the breeder.

The system of breeding, however, where the nature of the farm is such as to afford a supply of proper food to the animals, and where the finer class of stock is kept, is altogether different. In this case, the principle of the system followed, is to afford a full supply of food to the animal, from the birth to the time that it is transferred to the butcher. This principle applies to all animals intended to be fattened.

The calves, after being weaned, are put, it has been said, on good pasture, and fed for the remainder of the season. When the herbage fails in autumn, which is generally by the end of October or beginning of November, the animals should be put in straw-yards, with sheds, into which they may retire for shelter. The number put into one division or yard should not be too great, though this is less important at this period of their life than afterwards. Calves to the number of 20 may be kept together in one yard, provided they have plenty of room; but when animals are of a large breed, it is better that the number should not exceed 10.

The yards should have pure water in each, conveyed to them by pipes, and retained in troughs, to which the animals can have access at all times. Each yard should have, along one at least of the sides, shallow troughs, formed of wood or stone, for the purpose of holding turnips, and similar food. The yards should be so dry, that the animals may not be incommoded. The arrangement of these yards, with their sheds, will be seen in the design of farm-buildings afterwards given. Before bringing the calves home for the winter, the yards should be bedded with a layer of coarse straw, or dried stems of plants of any kind. In the middle of each of these yards should be placed one or more racks (Fig. 186 or 187), for containing straw, and preventing its being strewed about. The best kind of straw is oat-straw, and the rack should be kept constantly supplied.

Fig. 186



necessity for the reduction of the quantity of the richer food is much less than is supposed, for if substitutes for the turnip cannot be obtained, the quantity of stock may be reduced to the means possessed for carrying it on in a proper manner.

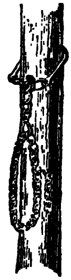
In all cases, then, the study of the feeder, must be to carry on the feeding animals with a full allowance of good food from their birth to their maturity. But the period at which he can relax a little in this system of full feeding, and substitute more common provender, is in the second winter. Yet even while he does relax to the extent of diminishing the more fattening food, he must take especial care that the animals, if they shall not gain fat, shall lose no part of their former condition. It is opposed to all the true principles of breeding to allow animals to fall off from the condition at which they had arrived.

It is not necessary, however, after the first winter, to give the same high feeding to the females intended for breeding, as to the males. The object proposed with the females intended for breeding, is not to render them fat, but to maintain them in a healthy and growing state. This is to be done, not by giving them a full allowance of the richer food, but such a portion of it only, as joined to the more common provender of the farm, will maintain them in a healthy state. When the yearling steers are to be carried on during their second winter, on a modified, and not a full allowance of richer food, then the heifers need not be separated from them, because both are to be fed in the same manner; but when the steers are at this time to receive full feeding, then the heifers are to be put into a yard with a shed by themselves. They should not be tied to stakes, according to the common practice, but kept in yards with sheds. In the following summer they are pastured along with the older cows, and receive the male as soon as they are ready to do so, which, in the case of heifers, is later than in that of the older cows. When winter comes, they are to be put into their separate pen again, and fed as in the first winter, and when within a few weeks of the period of calving, they may be tied up gently in their stall, or be put into a separate box.

But to return to the fattening stock :—The yearling steers are fed in their yards, either with their full allowance of straw and green food, or else with a full allowance of dried provender, and a modified allowance of green food. By the month of May they have completed their second year, and are now termed two-year-old steers. When the pastures are fully ready for them, they are turned out to feed, and are kept in these pastures until the herbage fails in autumn, when they are to be taken up once more and fed on green food in the fullest quantity in which they can consume it.

Two methods may be adopted in this final feeding of the animals. They may either be tied in the house, having a trough or manger to feed from, or they may be kept in small yards, with open sheds attached.

Fig. 188.



In the first case, that is, when confined to the house, or fed from a trough or manger, the animals are tied by the neck to upright posts. The best method of attaching them is by a light chain, which encircles the neck, and is fastened to a ring, moveable upon a stake. In this manner the animal has the power of raising and lowering his head with such freedom as permits him to lie down.

But instead of a series of upright posts, it is better that each animal have his own stall. A partition of wood at the heads of the oxen, or, a very good substitute, a broad stone, is placed between each animal. A bar of iron is then fastened to the stall, with a ring moveable upon it, to which is fixed the chain which goes round the neck of the animal. In this manner each ox is prevented from interfering with the provender of his neighbour, in the manner shown under the head Farm-buildings.

The other system of feeding is in small yards, with sheds. Each shed with its yard should be of a size to contain easily 2 oxen, or, if it is made of a size to hold 4 oxen, there should be a division between each pair, so that more than 2 shall not be together; and in the open yard, and close to the wall, should be fixed troughs for holding the provender.

Under this system of feeding, the animals have more freedom than when fed in close houses; and that moderate exercise, which, without impeding their fattening, tends to keep them in health. They receive the benefit of the sun and air, and have always the shelter shed to retire to. They have the power of going to their food at all times, even during the night, and this food being in the open air, is kept always fresh. The treatment of the cattle, too, in these sheds and yards is easy, and the injurious effects to the animals obviated of any deficient ventilation, or any want of care in the management. And experience has fully shown that the finest animals may be fed in these sheds, better even than in the warmest house, when they are tied to the stake.

But the latter practice of feeding is the more common; and it is the most necessary, too, to be described, because it requires greater attention on the part of the keeper.

When the cattle are for the first time to be fixed to their stakes, some care is needed to induce them to go forward. Gentle means must be employed; they must be somewhat tightly tied at first to prevent their turning round; and watched for a time lest they injure themselves by struggling. They must be well littered, and the turnips placed in the low manger of the stall before them.

Early in the morning the first operation to be performed is, to remove the dung from behind the cattle, and to place the turnips in the stall, the stems and tap-roots having been previously cut off. While the cattle are feeding, the dung is to be wheeled out of the house, and deposited in the yard or dung-pit. When the turnips are eaten up, a little good oat-straw or hay may be placed before the animals; and they being now littered, will soon lie down and chew the cud.

At mid-day they are again to be fed as before, and again before sunset, a little provender of hay and straw being placed before them after each meal; and finally, the keeper, before retiring for the night, is to examine them with a light, see that all is right, stir their litter, and place a little hay or straw before them. Under this system the oxen will be fully fed, and induced during the intervals of feeding to lie down, and left to repose during the night; or they will take a little dry food, should they be inclined to feed. Early in the morning the same process recommences; and the utmost regularity is to be observed in these operations, for the animals know the precise time of feeding, and become restless when it is not observed. Careful feeders currycomb their cattle in feeding, and in all cases observe that the skin is kept free from vermin, or other impurity.

Frequently the turnips are cut into slices by the turnip-slicer, (Fig. 47.) This, though not essential, is very beneficial, by enabling the animals to take the turnips more easily into their mouths, and masticate them. In spring the white turnips decay, and then there should be a succedaneum, first of yellow, and next of Swedish, turnips, which last retain their juices the latest in spring.

If the animals are kept in the yards with shelter-sheds, the principle of feeding is the same as that described; but the dung in this case is not removed from the animals, the litter being spread above it.

An ox of 50 or 60 stones weight will consume about a ton of turnips in the week, or about an acre in 24 weeks. If he thrive well, he will gain in weight 14 lb. or more in the week.

Sometimes cattle, especially when tied to the post, are apt to be choked by a piece of turnip sticking in the throat. In this case, the common practice is, to endeavour to push the piece of turnip gently, but firmly, down into the stomach by means of a flexible stalk, terminating in a round bulb of wood or bone.

The feeding with turnips is the most simple and economical method practised in this country. Turnips, however, cannot in all cases be raised in sufficient quantity, and in some cases they cannot be produced at all, and then, if a system of feeding is to be carried on, recourse must be had to other substances. Mangel-wurzel, the carrot, the parsnep, and the cabbage, are all suited to the purpose of feeding: and the manner of consuming them is so similar to that of the turnip, that when the mode of applying the one is known, that of using the others is easy.

Potatoes are also a nourishing food for ruminating animals. When given raw, they are applied in the same manner as the turnip; but care should be taken to begin somewhat gradually, because this food is apt to scour and injure cattle at first. Potatoes and turnips may, with great advantage to cattle, be given at the same time. Different kinds of food seem to have an exceeding good effect in promoting the tendency to fatten of all cattle; and in the case of feeding with potatoes and turnips, one meal of the former, and two of the latter, in the day, will be found to be a good arrangement. Potatoes steamed may be given to oxen; but steamed food is never of the same advantage to ruminating animals, as to animals with single stomachs, as the horse and the hog.

Bruised corn and meal are occasionally employed in feeding; but these are expensive, and only subsidiary to more common food.

Another species of feeding is the refuse of the distillery. This consists of the grains of malt after distillation, and of the wash or liquid refuse, and wherever these can be obtained, they may be applied to the feeding of cattle with success. They form a very nutritive food, rejected often at first by the animals, but afterwards consumed by them with eagerness. The grains may be given at the rate of from a bushel to a bushel and a half in the day, with a proper supply of dry food: the liquid portion, or wash, is drunk by the animals. The refuse of the brewery is in like manner used for the fattening of oxen.

Oil-cake is one of the substances employed in feeding. It is highly nutritive, is greatly relished by cattle, and it never fails to increase their tendency to fatten when given with their other food. It may be given in quantities of 2 lb. or more in the day, along with any other food. It is frequently given with hay alone, and the quantity that will feed an ox, is from 12 to 15 lb., with half a stone of hay in the day; but this is an expensive feeding, and the better mode of using oil-cake is to give it in small quantities, with less costly provender. It may be given with great benefit along with turnips. In this manner the turnips upon a farm may be economised, and a much greater number of animals nurtured upon it than would otherwise be practicable.

Salt should be given to feeding animals. The use of this universal condiment in the feeding of oxen, has been known from the earliest times. The quantity given may be from 4 to 5 oz. in the day to old oxen, to yearlings from 2 to 3 oz., and to calves ½ oz. All oxen will soon learn to take it if placed within their reach.

The general method of feeding oxen in this country in summer, is in the fields in the manner described; and this is the more simple and easy method, and that which is the most likely to be generally followed in a country abounding in pastures. The practice of soiling, however, has been often recommended, and partially adopted, in the feeding of oxen. But this has usually been in favourable situations with respect to productiveness of the soil. It is not a practice well suited to very young stock, which require moderate exercise, and do not thrive so well, when kept and fed in this manner, as when allowed to pasture in the fields. Soiling, therefore, when it is practised in any case, should generally be confined to the older stock, at the period of their final feeding.

The best method of keeping oxen when soiled is in the same small sheds and yards as are employed for feeding on turnips. The food must be carried home, and given to the cattle from racks, in moderate portions at a time. They must be fed three times, and may be fed four times, in the day; and they should be kept carefully littered. Between the period of consumption of the first crop of clover or other green forage and the second, there is sometimes an interval. At this time, therefore, there must be a supply of other food, as of tares, which, if sown in the preceding March, will be ready at this time, and will carry on the cattle until the other forage is ready for being cut a second time.

The rearing and feeding of cattle has been described from the birth to the maturity of the animals; but deviations from the modes described necessarily take place:—The breeder, in the case of certain farms, is not the feeder: He merely rears the animal to the maturity of age, or degree of fatness, which the nature of his farm allows, while other persons complete the process of feeding, in the manner which their peculiar situations render profitable or expedient.

The hardier breeds of the mountains are in general request for being fed in this manner. They are generally purchased lean before winter, and taken to all parts of the low country. They are there fed on straw, or coarse natural hay, during the first winter, with merely such an allowance of green food as can be spared; and they are either grazed and fattened in the following summer, or fed for another winter and summer, as suits best with their age and condition.

And not only the mountain breeds, but lean cattle of all kinds, in a more or less advanced state of age and fatness, are in the course of being transferred; and a great part of the profit of farmers depends upon the skill with which, on the one hand, they make their purchases, and, on the other, effect their sales of stock.

Calves, instead of being reared to maturity in the manner described, are frequently disposed of in a fattened state when young. The calves, under this system, may be transferred soon after their birth to the butcher, or they may be fed for a longer period on milk. In the latter case, they are rarely good veal in less than 5 or 6 weeks, and the most approved period for keeping them is 10 weeks. They are fed liberally on milk; but linseed cake and other fattening substances may be also employed. The cribs in which they are kept should be perfectly dry, well littered, and ventilated.

5. WEIGHT OF OXEN.

The parts of an ox to which the term *offal* is usually applied, are the head and feet, the tallow, the hide and horns, and the entrails.

The fat of an ox, it has been said, is that unctuous substance which is intermingled with, and surrounds, the muscles and other parts. That which grows internally is mostly termed tallow, and is generally considered to be of the same value, weight for weight, as the flesh of the fore-quarters; and so likewise is the hide. These and the other parts, termed offal, are commonly regarded as forming about one-fifth of the value of the animal. When beef is said to be sold at a certain price *sinking the offals*, the meaning merely is, that the whole price of the animal is reckoned upon the carcass alone; hence, when beef is sold at a certain price sinking the offals, that price is more than if it were sold without including in it the price of the offals.

That portion of the ox which is used for food, exclusive of the offals, is usually termed the quarters, because the animal, on being cut up, is divided into four parts or quarters. The most esteemed parts for food are the hind-quarters. These weigh somewhat less than the fore-quarters; though the more perfect the form of the animal is, the more nearly do the fore and hind quarters approach in weight.

Practice enables persons to judge of the weight of animals by the eye alone; but it is convenient to be able to ascertain the weight by measurement. This may be done with considerable correctness in the following manner:—When the animal is standing in a natural position, measure his length in feet from the foremost upper corner of the shoulder-blade in a straight line to the hindmost point of the rump; then measure the girth or circumference immediately behind the fore-legs; multiply the square of the girth by the length, and this product by .238, which will give the weight of the quarters in stones of 14 lb. each.* This rule has been arrived at by regarding the body of the animal as a cylinder, and determining, by experiment, what proportion, on an average, the actual weight of the quarters of animals bears to the cylinder.

Another method of ascertaining the weight of fat cattle, is, by weighing them when alive. One-half of the live-weight may be considered as equal to that of the four quarters; but in the case of fully fattened animals, a more correct result will be arrived at by multiplying the gross weight by .605.* This rule has been arrived at, by determining, from an average of cases, what proportion the dead weight of the four quarters is found to bear to the living weight of the animal.

6. Diseases of Oxen.

The diseases of the larger ruminating animals are not of very frequent occurrence, although they are often dangerous and fatal.

A malignant distemper, termed Murrain, has sometimes made dreadful ravages among the cattle of many countries, returning for successive years to the same country, and sweeping entire generations of cattle away. In the early part of the 17th century, it long raged on the Continent of Europe, and when it visited this island, continued its ravages for many years. But happily, since the period of its first introduction, its occurrence has only been partial and local

Cattle are subject to inflammatory diseases, which receive various names, as quarter-ill, black-quarter, showing-of-blood, &c. Bleeding at the commencement of these diseases is proper; but the subsequent treatment depends upon the stages of the disease at which the remedies are applied, and other circumstances.

Cattle are subject to colds, which frequently terminate fatally. Colds are brought on, amongst other causes, by sudden changes of temperature, whether of the atmosphere or of the place of feeding of the animal. Bleeding will in most of these cases be proper, and in all cases shelter should be afforded, and warm food supplied, as mashes, boiled turnips, and the like.

Cattle are subject to different diseases, which receive the general name of cholic or gripes. Diarrhœa and dysentery are also diseases of cattle, and many diseases might be mentioned; but it would be of no avail to enumerate them, without entering into details.

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* Memoir by Mr Fergusson of Woodhill.

In general, what falls within the province of the farmer may be comprehended under the head of food and general treatment. The medicines which he should venture to administer should be cautiously given. Where violent inflammatory diseases attack the animal, he may always venture to bleed in the first stage; when costiveness occurs, he may administer some laxative medicine; when diarrhœa or looseness occurs, he may give some laudanum, and in all cases mashes of boiled or steamed food. The bleeding of the ox, it is to be observed, should always be large.

One of the most frequent diseases of cattle, with regard to which the farmer has to act upon the instant, is hoven, or inflation of the rumen. The paunch, or first stomach, of ruminating animals, is of large size, and as the green food which is taken into it is frequently charged with moisture, the stomach is not only overloaded, and unable to carry on its functions, but the mass fermenting, air is generated, by which the stomach becomes so distended, that either a rupture of it takes place, or the animal dies of suffocation. This disease most frequently occurs when animals are turned into rich succulent pastures, particularly of clovers, when charged with the morning dews.

Sometimes powerful stimulants are given to assist the action of the stomach, and these are often sufficient; or a hollow flexible tube is introduced into the stomach through the mouth, that the air may be permitted to escape. Should this operation not succeed, then an opening must be instantly made through the left side into the paunch. This is usually done by a pen-knife, while a quill, or something similar, is introduced, to allow the air to escape. But recently the stomach-pump has been employed for this and other diseases, and with the best effects. It is fitted to withdraw instantly the contents of the stomach, and also to inject liquids, so that, when the mass of the stomach is too hard, the matter may be first diluted by injected liquids, and then withdrawn. The stomach-pump is also suited to various diseases of the horse, and may be formed of smaller size for the sheep; so that, by means of this instrument, the lives of many valuable animals may be saved upon a farm.

7. THE DAIRY.

Milk is a secreted liquid intended for the nourishment of the young of mammiferous animals, and to this end it is eminently adapted. By agitating this substance, it separates into two parts, a fluid and a solid. The solid part is butter, having the properties of an expressed oil. The fluid part is merely the milk deprived of its butyraceous part; and when it is obtained by the operation of churning, it receives the name of butter-milk.

But, if milk is left at rest for a time, it becomes acescent, and coagulates. This coagulation takes place of itself; or it may be produced by adding certain substances to the milk, as acids, alcohol, the juices of certain plants, and the gastric juice of animals. The coagulated portion of the milk is curd; which, when the liquid is expressed from it, forms cheese. The liquid that is thus separated is termed whey. Whey, therefore, is milk deprived of its caseous or cheesy matter.

Again, milk, if left at rest for a time separates into two parts; a more oily part, which rises to the surface, and is termed cream; and a more serous part, which, when the cream is removed, is termed skimmed milk. A portion of the cream still remains attached to the more serous milk, and the latter is a nutritive substance, employed largely as human food, and for the feeding of calves and other animals.

It is from the oily or creamy part that butter is derived. It may be allowed to rise to the surface, and then being removed from the more serous part, be churned, or the whole, namely, the serous and creamy part, may remain, mixed together and be churned. In either case butter will be obtained. In the first case, the butter will be of better quality; in the second, it will be produced in larger quantity.

The caseous or cheesy matter may be obtained by coagulation from the serous portion of the milk alone. But in this case it is less rich and grateful; for when all the creamy part remains with the milk, a portion of it unites with the cheesy part. Hence, when it is wished to procure good cheese, the creamy part is not removed from the milk before coagulation.

The manner of separating either the butyraceous part of the milk by agitation, or the cheesy matter by coagulation, is so easy, that it is not surprising that the means of doing so should be everywhere known and practised. Butter and cheese form, in all the temperate parts of the world, extensive articles of food; but in warmer countries, the oil of plants is largely used, in place of the oily part of milk.

In the practice of the dairy in this country, milk may be disposed of in three ways.

The first is in the form of milk for food; and this is the most profitable where, from the nearness of the market, and the demand for the produce, it can be adopted. In the vicinity of towns, accordingly, dairies are formed merely for the production of milk; and these usually form the largest class of dairy establishments. But the sale of milk in its fresh state is necessarily limited to a certain circle around the different markets of consumption.

The next and most profitable production of the dairy is butter in a fresh state. This circle is more extended than that of milk alone, because butter can be preserved longer, and conveyed to a greater distance.

At a greater distance still the produce of the dairy consists chiefly of cheese, or when butter is produced, it is salted for preservation, and not disposed of in its fresh state. It is for the combined production of cheese and butter that dairies are usually made; and a dairy, that it may fulfil these purposes, should consist of several apartments:—

1. The milk-room.
2. The work-room.
3. The store-room.

The milk-room is intended to contain the milk previous to obtaining from it the cheese or cream. It should have its windows to the north, and be so formed as to preserve a cool and equal temperature. It should be well ventilated, kept dry and clean, and be as much as possible removed from the effluvia of putrid substances. The windows should be formed of gauze-cloth, which may exclude flies but admit the air, and protected from mice and accidents by a grating of wire. This apartment should be kept cool in summer, but in winter heated by a stove or otherwise, so as to maintain a temperature of from 50° to 55°.

The work-room is that in which the different manual operations are performed. It is to be fitted up with a boiler to boil water and heat milk, and it should be of sufficient size to allow of performing the operations of churning, cheese-making, washing the dairy vessels, and the like. But when the dairy is of the larger size, there should be more than one apartment; namely, one for churning, one for making the cheese, and one for cleansing the vessels.

The store-room is intended merely to keep the cheeses when made. It may be placed wherever convenient, and should have a certain degree of warmth, without being too much heated or lighted.

The utensils required for a dairy are:—

1. Milking-pails, which may be formed of wood: 2. Sieves of hair or wire-gauze, for the purpose of passing the milk through and retaining the impurities: 3. Vessels for holding the milk until the cream rises upon the surface, and a vessel for containing the cream: 4. Flat dishes of willow, ivory, or horn, for the purpose of skimming the cream from the surface of the milk: 5. A churn: 6. A wooden vat or tub, in which the milk is placed when the curd is coagulated: 7. A cheese-knife, for the purpose of cutting or breaking the coagulated curd, that the whey may be separated: 8. A vessel perforated with holes, in which the curd may be placed, that it may be broken, and the serous matter further separated: 9. Wooden vessels, with perforated side and bottom, in which the curd is placed for being compressed: 10. A cheese-press.

The utensils more especially employed for the making of butter are the dishes for holding the milk until the cream separates, the skimming dishes for removing the cream, a vessel for holding the cream, and the churn.

The dishes for containing the milk are made of various substances, as marble, slate, tinned iron, earthen ware, and wood. Lead is sometimes employed, but improperly, as it may be acted upon by the acid of the milk; and so likewise may iron, if not defended by a coating of some substance. The milk may either be contained in one large vessel or trough, with a stop-cock at the bottom so that the milk may be withdrawn, leaving the cream in the trough, or it may be put in separate shallow vessels. These last have been recently made of cast-iron, smoothed within and coated with tin; and more recently zinc has been employed. Either of these substances is superior to the more common material, wood. They are more easily kept clean, and sooner cooled, which contributes to the more ready separation of the cream.

Churns are of different construction, the most common of which is that of a plunge-churn, moved by the hand. The form of this domestic instrument is every-where known. It consists of a cylindrical vessel of wood, placed upright; and the agitation is given to the milk within by a perforated board, which nearly fits the cylinder, and to which is attached a long handle. This being moved up and down, agitates the milk until the butter is separated.

Sometimes in place of a cylinder standing upright, there is employed a small barrel placed horizontally, and sometimes a square box. Through the box or barrel there passes a wooden axle, to which arms are attached, and motion being given by a handle, the milk is agitated and the butter separated.

Sometimes in the larger class of dairies, the churn is driven by machinery. The best principle of construction, it is conceived, is that of the plunge-churn, by which a greater agitation is given to the milk, and the operation more effectively performed, than by arms revolving in a uniform direction. The following figures represent a churn of this construction.

Fig. 189.

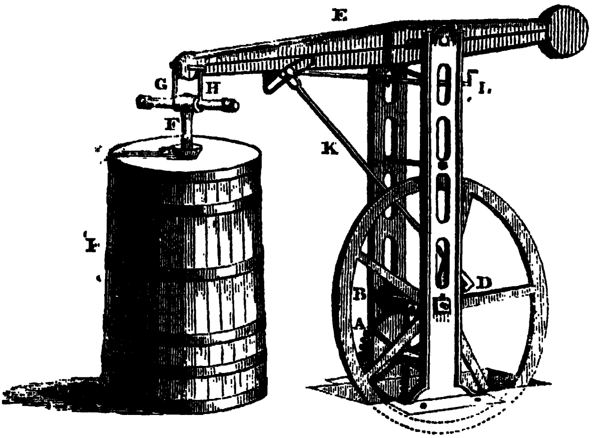
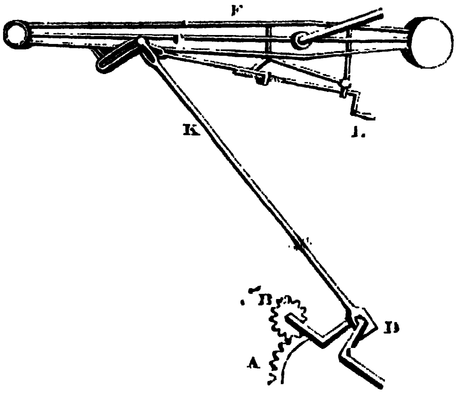


Fig. 190.



If a water-power is not at command, the machinery may be driven by a single horse attached to a shaft at the outside of the building. Motion is conveyed by a lying shaft to the wheel A, and this, by the pinion B, gives motion to a shaft, on which is a crank D, as seen in Fig. 190. By this crank, and the connecting rod K, motion is conveyed to the beam E, which is thus alternately raised and depressed. To this beam is attached the handle F at the two points of the cross-handle G and H. This handle passes through a hole in the lid of the churn I, and to the lower part of it is fixed a circular perforated board, filling the greater part of the churn. Motion being given to the machine, the handle is raised and depressed, and, by a rapid succession of strokes, the milk is speedily churned. In order to render the strokes longer or shorter, as may be wished, the end of the connecting-rod K can, by means of the screw L, be moved nearer to or further from the centre of motion of the beam. When it is nearer to the centre, the end of the beam makes a larger sweep, and longer strokes are given by the handle. The size of the churn may be sufficient to contain 70 gallons of milk or more; or, there may be two churns, with handles attached to the same beam. This machine has been found to be greatly superior in efficiency and despatch to any that had been before in use.

Butter may be obtained either by separating the cream from the milk and then churning it, or by churning the milk and cream together. By the first method the best butter is obtained; by the second, the largest quantity.

When the first method is practised, that is, when the cream is churned by itself, the milk, immediately on being brought from the cow, is put into vessels to cool. These vessels may either be the large trough referred to, or the shallow separate vessels. The milk is put into the trough or vessels from 5 to 6 inches deep; it remains undisturbed for a period of not less than 24 and not more than 48 hours, the medium being 36. The cream which has risen to the surface is then separated from the milk; in the case of the larger trough, by having the milk withdrawn by a stop-cock; and in the case of the smaller vessels, by the cream itself being skimmed off by a flat dish. The cream is then put into a vessel until a sufficient quantity of it is collected. Fresh portions of cream are added to this vessel as they are procured from successive milkings, and the whole soon acidifies.

After a sufficient quantity of cream has been collected, it is put into the churn, is then churned, and in the space of about an hour the butter will be separated. The best temperature of the cream for the separation of the butter appears to be about 60°, and in cold weather it may be raised to this temperature, or somewhat higher, by the addition of some hot water, or when the small churn is used, by plunging the churn into hot water.

The butter is now removed, and is carefully washed and kneaded in cold water until all the milk is separated, which will appear by the water coming off pure. After this the butter is fit for present use, or it may be salted for preservation.

This is the method practised when the cream is churned separately, but when the cream and milk are churned together, the practice is somewhat different:—

In this case, all the milk of one milking of the cows is put into the cooling-vessels, so that it may cool down to the temperature of the milk-house. It is then, with the cream, put into a large barrel, where it becomes acid, and a slight coagulation takes place. It may remain in the barrels from two or three days to a week; and when a sufficient quantity is collected it is put into the churn, and, after being churned a few seconds, is raised to the temperature of from 70° to 75°, by the addition of hot water. Some do not add hot water; but the practice is not injurious, and saves labour. In two or three hours when the hand-churn is used, and in an hour or an hour and a half when the larger churn, driven by machinery, is employed, the milk will be sufficiently churned.

By thus churning the whole milk and cream together, a larger quantity of butter-milk will be procured, and of better quality, than when the cream is churned separately. The butter-milk procured in this manner is but slightly acid, and is a wholesome and agreeable food to those who are used to it; and it is perfectly nutritious, all the caseous matter of the milk still remaining.

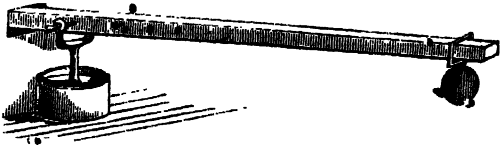
When the churning process is completed, the butter is, as in the former case, removed and kneaded in cold water until all the milk is separated and the water comes off pure. In this state it may be formed into rolls for present use, or salted for preservation.

The other preparation of milk is cheese.—Cheese consists of the caseous matter of milk united to a certain portion of the oily or creamy part. This oily portion adds to the flavour and richness of the cheese, and hence, when good cheese is wanted, the cream should not be separated. Cheese, however, can be made from milk from which the cream has been removed; and it is then termed skimmed-milk cheese. It may even be made from butter-milk, in which the cheesy part entirely remains. But then, the creamy part being more withdrawn than in the case of skimmed-milk, the cheese wants still more the properties and flavour which are valued in this species of food.

For the making of cheese, the utensils usually required are; —a large tub, in which the milk is coagulated, and the curd broken; the cheese-knife, sometimes of wood and sometimes of iron, with one or more blades for cutting the curd and allowing the whey to separate; wooden dishes for removing the whey; generally another wooden vessel perforated with holes, for further expressing the whey; small circular vats, in which the cheese is placed that it may be compressed; and finally, the cheese press.

Cheese-presses are of different forms. They are generally made to act upon the curd by the continued pressure of a weight. The most simple, perhaps, is a long beam, made to act as a lever, the cheese to be compressed being placed in its vat, between the weight and the fulcrum, thus—

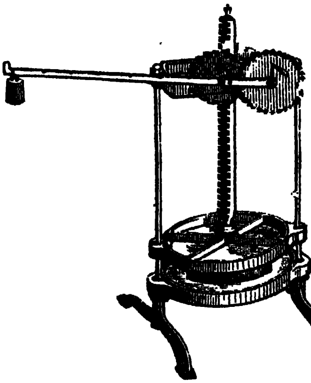
Fig. 191.



But more complex forms of the cheese-press, and, in some cases, more convenient, may be adopted. The following figure represents a press, in which the weight is attached to a lever, and acts on a board which is placed above the curd, by a series of intermediate wheels and teeth :—

The coagulation of the milk is produced by various substances, but the most approved is rennet, which is prepared from the fourth stomach of a young calf. This substance may be obtained as follows:—

Fig. 192.



The stomach of a new-killed calf, with its contents, consisting chiefly of coagulated milk, is to be taken. The matter of the stomach is to be preserved, separating merely any indigested substances, as straw and the like, that may be mixed with it. It will add to the quantity of rennet obtained to feed the animal largely with milk, some hours before it is killed. A few handfuls of salt are to be put into the stomach and all around it. It is then to be rolled up, and hung near a fire to dry; and its quality will improve by hanging it up a year or more before it is used. It is the gastric juice in this rennet which produces the coagulation of the milk.

When the rennet is prepared for use, it is cut into small pieces and put into a jar, with a handful or two of salt. Water, which had been previously boiled and cooled again, is then poured upon it, and allowed to remain for two or three days. It is then drawn off, and a second infusion made, but with a smaller quantity of water. This also remains a few days, and being withdrawn, the two liquors are mixed together, strained through a cloth, and put into bottles, to be used when required.

The usual manner of making cheese is the following:—The milk is put into a large tub, and this as soon after being obtained from the cows as possible. If there is a sufficient number of cows upon the farm to produce one cheese at a milking, the process is performed immediately on the milk being brought from the cows. The milk, after being strained through a sieve, is put into a vat, and while yet warm, a table-spoonful or two of the rennet is mixed with it, after which the coagulation soon takes place.

But if there be not a sufficient number of cows to make a cheese each time they are milked, then the milk, as it is brought from the cows, is put into the milk-vessels until as much is collected as will form a cheese. When the cheese is ready to be made, the cream is skimmed off, and as much of the milk is heated separately as, when added to the mass again, will raise it to about 90°. The cream which has been separated is then either mixed with this heated milk, and so liquefied and dissolved in it; or it is not added to the general mass until the heated milk has been added.

The curd being fully formed, it is cut in various directions with the cheese-knife, so as to allow the whey to exude; and the whey is then lifted out in flat dishes, the curd at the same time undergoing a gentle pressure. The curd is then cut into small pieces by the cheese-knife, and put into a sieve or vat with holes, and then repeatedly cut, pressed by the hand, and broken, until it ceases to give off any serous matter. It is last of all cut very small by the cheese-knife, and a quantity of salt, in the proportion of about half an ounce to a pound of cheese, being mixed with it, it is wrapped in a piece of cloth, and then put into a small wooden vessel with circular holes at the sides and bottom, and placed in the cheese-press.

The time during which the cheese remains in the press is dependent upon the nature of the cheese and the degree of previous manipulation which it had undergone. In some of the finer and richer cheeses, the pressure is very slight, and in some cases the cheese-press is altogether dispensed with.

But in ordinary cases, the cheese being wrapped in a cloth, and put into its vat, with a board above it to fit the vat, remains in the press from one to two hours. It is then taken out, broken again by the hand, wrapped in fresh cloth, and replaced in the cheese-vat; and sometimes it is not broken, but merely reversed. It may then be taken out every five or six hours, and the cloth changed. After being pressed in this manner for two or three days, the operation will be complete. The cheese may then be kept in a warm place for some time till dry, and ultimately placed in the store-room for preservation.

But great variations take place in the manner of performing the operation of the cheese manufacture; and certain districts are distinguished by their peculiarities of practice. In England, more care is generally employed than is thought necessary under the system of management adopted in the dairy districts of Scotland.*

The richness and flavour of cheese very much depend upon the quantity of cream which the milk contains. In some of the districts of England most celebrated for rich cheese, the cream of one milking is skimmed off and mixed with the entire milk of the subsequent milking. In this way the milk which produces cheese has its own cream and that also of a previous milking.

It is a frequent practice to colour the milk, so as to give a red tinge to the cheese. This is now generally done by a preparation of the red pulp surrounding the seeds of the arnotta tree. This adds nothing to the goodness of the cheese, but the mixture is harmless.

The residuum, after the separation of the curd, it has been said, is whey. The substance is chiefly employed to feed hogs, and is exceedingly well suited to that purpose.

These are the principal details which it is thought necessary to give regarding the preparation of these salutary and nutritive substances. By means of the dairy, a larger quantity of nutriment can be obtained from the consumption of an equal quantity of herbage than by any other species of feeding. The dairy forms an important branch of public industry, and contributes in a material degree to the support of the inhabitants of this and other countries of Europe.

In the practice of the farm, where the main end is rearing animals for feeding, the kinds of animals will be selected for breeding which are the best suited for that purpose; and the production of milk will be regarded as secondary and subordinate. But when the principal end is the production of milk, then animals will be selected the best adapted for yielding rich and plentiful milk.

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* Account of Cheshire by Mr Holland. Account of the Dairy Husbandry of Ayrshire by Mr Aiton.

The form of animals that are best fitted to arrive at early maturity and secrete fat, differs in some respects from that which indicates a disposition to secrete and yield milk. A dairy-cow, like a fattening animal, should have a skin soft and mellow to the touch,—should have the back straight, the loins broad, the extremities small and delicate; but she need not, as in the case of the feeding animal, have the chest broad and prominent before. She should rather have the fore-quarters light, and the hind-quarters relatively broad, capacious, and deep; and she should have a large well-formed udder. There should be no breeding *in-and-in*, as in the case of a feeding stock. The purpose in rearing cows for the dairy is not to produce animals that will arrive at premature age, but such as are hardy and of good constitution. By long attention to the characters that indicate a disposition to yield milk, the breed of Ayrshire has become greatly more esteemed for the dairy than other animals much superior to them in size and fattening qualities.

With respect to the manner of feeding the cows of the dairy, the most economical, perhaps, is feeding them entirely on green forage during the summer, and in winter on carrots, potatoes, parsneps, and cabbages; or chaff and similar substances steamed; or coarse meal, bruised beans, and other farinaceous food: or distillers' wash, and other nutritive substances. This is the manner of feeding adopted in the large dairy establishments of towns; and it is the practice pursued in various parts of Europe.

But in a country of abundant pastures and enclosures, the cows may be allowed to pasture in summer, and be only stall-fed in winter. This is the practice adopted in most of the dairy districts of this country. During the heat of summer, however, the cows should be housed during the heat of the day, and fed at that time on green forage, and turned out to pasture only in the cool of the evening.

In winter, the cows of a common dairy may be fed on cabbages, potatoes, and the like: and it is a good practice in many cases to steam a portion of their food, and to mix salt with it, at the rate of from 2 oz. to 3 oz. in the day for each cow.

In summer, the cows are either milked in the field, or they are driven gently home to the dairy and milked close to it. Many skilful dairy-farmers prefer the latter practice, in order that the time of the milkers may be saved, and the milk transferred speedily to the vessels of the dairy. The cows, when in full milk, should be milked three times in the day, and at other times twice in the day will suffice.

The quantity of milk yielded by cows varies greatly with the health, constitution, and treatment of the animals. After calving the cow yields her milk in the largest quantity. She after a time yields less and less until she approaches the period of bringing forth her young, for six weeks or more previous to which she tends to become dry: and this natural provision should be favoured, and not prevented, as is sometimes attempted. If a cow is not in calf, she continues to yield milk for a long period, sometimes for several years.

On a well managed dairy-farm, where a proper breed of dairy-cows exists, and where the cows are fed on herbage and green forage in summer, and stall-fed in winter, the average yearly produce may be reckoned at from 600 to 800 gallons for each cow. Somewhat more than 2 gallons of milk will yield about 1 lb. of butter; and about 1 gallon of milk will yield 1 lb. of cheese.

III. THE SHEEP.

1. SPECIES AND VARIETIES.

The origin of the domestic sheep has been sought for by naturalists in various wild races.

1. Ovis musimon—The Musmon.
2. Ovis ammon—The Argali.
3. Ovis montana—The Rocky Mountain Sheep.
4. Ovis tragelaphus—The Bearded Sheep of Africa.

The Musmon of the Mediterranean islands is yet found wild in Corsica and Sardinia, in the mountains of European Turkey, in Crete, and other islands of the Archipelago. It does not differ greatly in its characters, but it differs widely in its habits, from the domestic races of Europe.

The Argali or Wild Sheep of Asia, inhabits the mountains of Central Asia, and the elevated plains of Siberia northwards to Kamschatka. It has horns of great length; its colour is gray, and it is covered with wool beneath a close hair.

The Rocky-mountain Sheep is an animal of great size, and inhabiting the mountainous parts of North America. But it is believed by many naturalists that the Rocky-mountain sheep of America is not specifically distinct from the argali of Asia.

The Bearded Sheep of Africa is found in Barbary and the mountainous parts of Egypt.

These are the wild animals of the race of sheep that have been yet discovered. Which of them, if any, has given rise to the domestic races has been matter of dispute.

The domestic sheep is usually termed *Ovis aries*. The female goes with young twenty-one weeks, and generally brings forth her young in spring. She produces one, and often two, but rarely more than two, at a birth. She yields milk in quantity sufficient to nourish her young. Her milk produces little cream; but the quantity of caseous matter is comparatively large. This, when made into cheese, is wholesome, but strong tasted.

The sheep appears to attain his most perfect state as to size and form in the temperate zone. He is there covered with wool, whereas in warmer countries he is more covered with hair, as he also partially is in the colder countries, where his size is likewise diminutive. The wool of the sheep for the most part falls off and is renewed every year: and the period of its falling off is early in summer:

In its natural state the sheep has horns; but in the domesticated races the horns frequently disappear, and the most valued breeds are entirely destitute of them. The sheep is a very hardy creature with regard to the effects of temperature, its thick coat of wool defending it well from cold and moisture. It has been known to live for a long time under snow. It is a harmless and timid creature, and in its domesticated state is dependent upon man for protection and food. In mountainous countries, however, where it is less domesticated, and must trust greatly to its own resources, it manifests its instinctive powers of self-protection. It scratches up the snow with its feet in search of food: it is conscious of an impending storm, and takes the means to secure itself from its violence: it is wary and vigilant, and numbers have been known to combine for defence against beasts of prey. But though, under these circumstances vigilant, and in cases of necessity bold, all the habits of this creature lead it to submit to the dominion of man, and from the earliest times accordingly it has been the subservient instrument of our race.

Whether the wild race of sheep be all of one species, as some naturalists suppose, or of different species, as others maintain, the domestic races with which we are familiar in this island are of one species; and what we term breeds are merely varieties produced by different conditions of situation, food, and culture.

The principal breeds of British sheep may be thus classed,—

1. The breed of Zetland and Orkney.
2. The breeds of Wales.
3. The Mountain breeds of Ireland.
4. The Black-faced Heath breed.
5. The Cheviot breed.

6. The Southdown breed.
7. The Ryeland breed.
8. The Norfolk breed.
9. The Wiltshire breed.
10. The Dorset, Somerset, and Isle of Portland breeds.
11. The Merino breed.
12. The Penniston breed.
13. The Dartmoor, Exmoor, and other Forest breeds,
14. The Old Lincolnshire, Romney-marsh, and Devonshire breeds.
15. The New Leicester breed.
16. The Cotswold breed.

The Zetland and Orkney sheep exist in the islands from which they take their name. They are essentially the same in the various islands, though, in most cases, they have been more or less crossed with stranger blood. The pure breed is of the variety of short-tailed sheep, which exist in Norway and other parts of the north of Europe. They are amongst the least of our races of sheep. Their fur consists of a fine soft wool, mixed more or less with hair. It is of various colours, white, black, or yellowish-brown; and often it is of a mixed colour of white and black. It is the Zetland variety which is the most noted for the fineness of its wool. All these sheep are hardy, and suited to the exposed country and barren pastures where they are reared. They would doubtless enlarge in size were they naturalized in a lower country; but it does not appear that any purpose of useful economy would be served by extending them to other parts of the country. It is rather to be desired that the native stock shall be improved, or a superior one substituted.

The breeds of Wales consist of two principal groups: the first comprehending a race of wild little sheep, inhabiting the highest mountains: the second inhabiting a somewhat lower range, and spread throughout the entire country. It is this latter variety which forms the most important of the breeds of Wales. The sheep are of small size and peculiar form, the hinder extremities being long, as if to fit them for vaulting as well as running. The ram has generally thin white horns; the females are destitute of horns. The wool is short, soft, the fleece is frequently dun, brown, or black, and, like the other sheep of Wales, the animals tend to throw off the wool of the neck and shoulders early in spring; for which reason these parts are clipped before winter, and hence it is, too, that the practice of "wool-gathering" still exists in Wales. These little sheep are exceedingly wild and shy. They rise on their hind legs to browse like goats, and they crop the tops of shrubs and grasses. Their mutton is excellent, and numbers of them are fed in all the adjacent plains for the consumption of the capital and other opulent towns. Allied to this race, and manifestly of the same origin, are the Old Radnor, the Anglesea, and other varieties.

Of the mountain breeds of Ireland, the most important is that of the Wicklow mountains. These sheep have much of the aspect of the smallest class of Cheviots. Their wool is fine, but with a mixture of hair and coarser wool. They supply the market of Dublin with smaller mutton, which is held in esteem. In the mountains of Kerry is reared a race of very small sheep, wild, and slow feeders, but turning out better than their appearance indicates.

The Black-faced Heath Sheep are the natural inhabitants of a country of mountains and heaths. Their wool, though shaggy and coarse, is light.

They are of the smaller class of sheep, but hardy, bold, and active: they have horns, and the legs and faces are black; they feed readily when brought to good pastures, and their mutton is in great esteem.

This race of mountain sheep is found on the moorlands of Yorkshire, on the highlands of Cumberland and Westmoreland, on the mountains of the south of Scotland, in Argyllshire, and all northwards through the Western and Central Highlands. The best examples of the breed are usually found in Tweeddale and the adjacent districts.

For an elevated and rugged country, where the chief pasture is heath, this breed is exceedingly well suited. The objection to it is the

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black-faced breed. But although the Cheviot breed is superior to the black-faced in weight and value of the wool, it is not possessed of the same hardy qualities, and the black-faced may therefore be cultivated with advantage in situations to which the Cheviot is unsuited.

The black-faced breed though well defined, loses many of its characters when naturalized in a low, marshy, or less heathy district. Its wool becomes less coarse; the darkness of its colour diminishes; its legs and face become spotted and gray; and its horns sometimes disappear. Hence this breed is in some places so changed in its external characters as to have lost much of its resemblance to the parent stock.

The next to be mentioned of the mountain breeds is the Cheviot, so termed from its being reared in the mountains round Cheviot; whence it has been very widely extended to other elevated districts.

The Cheviot sheep are heavier than the black-faced. They are without horns, and the wool is fine. They are hardy, active, and well suited to an elevated country.

The mountains where this race of sheep is indigenous, though high, are mostly covered with green sward, and thus differ from the heathy mountains of other parts. The nature of this range of pasturage may have contributed to give its peculiar character to the breed, and considerable care has for many years been bestowed by breeders on its improvement. In these improvements, attention having been more directed to the form and size of the animals than to the quality of the wool, the latter has increased in quantity though it has diminished in fineness. The Cheviot breed presents somewhat different characters, according to the nature of the country where it is reared, and the views of breeders. In those cases where artificial food can be supplied in considerable quantity, breeders prefer a larger form of the animal, with shorter legs. On more elevated pastures, and under less favourable circumstances, they are chosen of a lighter form and with longer limbs.

The properties to be desired in a mountain breed are, that it shall be hardy, of good form, of sufficient size, and with good wool; and for a combination of these qualities, the mountain breed of the Cheviots has certainly not been surpassed in these islands.

The Southdown is a breed of fine-woolled sheep, extensively spread over the south-eastern counties of England. They may be said to be proper to the chalky districts, although now carried to other parts. They are without horns, their legs and faces are gray, and until improved by breeding, they have the light fore-quarters of mountain sheep. Their wool is short and of good quality, and their flesh is of excellent flavour. They are kindly feeders, and well suited to an extensive range of the lighter soils.

These sheep have been reared from time immemorial on the chalky soils of Sussex, whence they have been spread into other districts; and their general diffusion has effected a great change on the short-woolled breeds of this country. A considerable proportion of the breed has been little improved; but another part has been brought, by the care and skill of breeders, to the highest perfection of form and fattening properties. But in these improvements attention having been mainly directed to the properties of form, the fineness of the wool has been somewhat diminished, though its quantity has increased.

The Ryeland, forming the ancient breed of Herefordshire, is early mentioned amongst the fine-woolled sheep of England. This pretty breed has nearly merged in the crosses that have been formed with it, and remnants only of the pure Ryelands remain. They are of small size and destitute of horns. Their wool is exceedingly fine, weighing about 2 lb. the fleece. They are kindly feeders, and their mutton is excellent. The Ryelands were extensively crossed with the Spanish Merinos soon after the introduction of the latter into England, and the produce was brought into notice under the name of Merino-Ryeland or Anglo-Merino. Great exertions were made to extend this new cross; but though good wool was produced, the breed itself quickly declined in favour. The effects of these and other crosses, are still to be traced in a mixed race of descendants. But it is to be regretted that the old breed should now be so nearly lost. The defect of the Ryeland was the smallness of its size, but by judicious crossing, this defect might have been corrected in the progeny, and the Ryeland made the basis of a useful breed of fine-woolled sheep.

The Norfolk is a remarkable race of sheep occupying chiefly the higher lands of Norfolk, Suffolk, and Cambridge. They are a powerful race of animals, with long muscular limbs, and with horns which in the male are very long and twisted. Their legs and faces are entirely black; their wool is short and fitted for the making of cloths. They are of a wild and restless habit. They afford admirable first crosses, for the markets of consumption, with the Leicester and Southdown sheep, and in an especial manner with the Southdown; but from the effects of this system long continued, the pure old Norfolk is in danger of being lost as a separate variety.

The Wiltshire at no distant time occupied nearly the whole of the county of that name. They are now almost extinct as a separate variety, having merged in the crosses that have been made with them, or given entire place to the Southdowns. They were the largest of the fine-woolled sheep of England. They were of an exceedingly coarse form. Their heads were large, their limbs thick, and the rams had strong horns. Their fleeces weighed about 2½ lb.; but their bellies were almost destitute of wool. They were very slow feeders, but their mutton was good, and the wethers arrived at considerable weight.

The Dorset breed, so named from the county of Dorset, has been carried to other parts chiefly within a circuit round London. The male and female have short horns; their legs and faces are white. Their wool is good, weighing from 3 to 4 lb. the fleece and upwards. They have a resemblance in form to the Spanish Merinos. The females are prolific and abound in milk, and are remarkable for their tendency to receive the male at almost any season. On this account they are employed to yield lambs for winter consumption: but the rams employed for this purpose are not usually the Dorset, but the Leicester or the Southdown.

Allied to the Dorsets, and employed for the same purposes, are the pink-nosed Somerset. These are believed to yield a larger lamb, but not to be such good feeders or nurses as the true Dorset.

Allied in general characters to the Dorset and Somerset breeds, is a peculiar race which inhabits the Isle of Portland. These sheep have been kept unmixed for an unknown period. They are gentle, of very small size, and of good form.

The Spanish Merino breed, now partially naturalized, was introduced into this country in the year 1788. Soon afterwards the rams were made to cross the Ryeland, the Southdown, and other fine-woolled breeds of England. King George III. had introduced rams of the Merino breed from Spain, and cultivated it with care. In the year 1804, the sales which then began of his Majesty's stock attracted great attention to the breed; and, in the year 1811, a society was formed for the purpose of encouraging and extending it.

The result of the crosses with the native sheep did not fulfil the expectations formed. The wool of the native sheep was indeed improved in quality; but this was accompanied by defects in the characters of the animals themselves not to be compensated by the increased value of the fleece. The sheep of the mixed breed nearly all proved defective in their forms, slow feeders, and less hardy than the parent stock.

Flocks, however, of the pure Merinos have been preserved, and the progeny of these has remained superior to the new or cross-breeds. The naturalized Merinos retain their natural characters, though the wool becomes longer and heavier than in Spain, and the body more large. But the entire form of the Merino as a fattening animal is bad, and the return in mutton deficient both in quantity and value. It is vain that some breeders still contend for the superiority of the pure Merinos: the general judgment of farmers is against them; and with perfect reason.

Could the breeders of this country look more to the fleece than the weight and value of the animal, as in Spain and the parts of Germany where the Merinos have been naturalized, the culture of the breed might become profitable. But the breeder in England finds it his interest to direct attention mainly to the weight and value of the flesh; and while this is so, it will be more advantageous that this country import the wool of other countries, than that the feeders either adopt an inferior animal, like the Merino, or sacrifice the more essential properties of the native sheep.

A singular breed of sheep occupies an elevated district of the coal-formation on the confines of Yorkshire, Lancashire, and Derbyshire. It is termed the Penniston breed, from the market town of that name, lying to the south of Huddersfiel in Yorkshire. The sheep are distinguished by their coarseness of form, especially of the extremities, and in a remarkabl manner by their thick muscular tails. The rams are very larg in proportion to the ewes.

There were various breeds of sheep proper to the old forest of England. The remains of some of these curious old breeds still exist, but for the most part, they have become extinct, by the division of the forests, or been merged, by the effects of crossing, in other races. Of these forest breeds, two may be mentioned, the Dartmoor and the Exmoor, so named from the districts which they respectively inhabit. The one is found on the high granitic range around the forest of Dartmoor; and the other on a no less steril tract at the source of the river Exe, on the confines of Somersetshire. The Dartmoor sheep have white faces and legs, and the males have horns. They produce excellent mutton, which has been long known in London under the name of Oakhampton mutton, the animals being killed there, and their carcasses carried thence to London. But the term Oakhampton mutton is applied also to the Exmoor sheep killed at the same place, as well as to the crosses between these two breeds respectively and the larger sheep of the lower country. These wild little sheep are reared in their native pastures of heath, and fattened in the lower country. They are gradually disappearing in consequence of the effects of crossing. They are chiefly crossed by the Southdown or Leicester, and the crosses with the Leicester are preferred. The Exmoor are yet smaller, more wild, and more untractable than the Dartmoor. Both males and females have horns, with white faces and legs. Their wool is long and soft. The males are distinguished by a beard beneath the chin. These sheep are, like the Dartmoor, rapidly disappearing by the effects of crossing; they are giving place to other breeds, and especially to the Cheviots, which have been introduced into this district with great advantage.

The races of sheep that have been referred to may be said to be proper to the mountains, lower moors, and chalky downs. The sheep of the lower country are usually of a larger size, and more productive of flesh and wool, and they are all destitute of horns.

The breeds of this class to be here referred to are the Old Lincoln, the Romney-marsh, the Devonshire Notts, the New Leicester, and the Cotswold.

The Old Lincoln formed a race of coarse heavy sheep, bearing an enormous fleece of long wool. In this respect they were the most remarkable sheep in Europe. But few of the ancient race remain, nearly all having been crossed more or less by the lighter sheep of modern times. These crosses, however, are still very weighty animals, and afford large supplies to London and other markets of consumption. They are fed in numbers on the rich marshes of the Thames and elsewhere. They frequently weigh from 50 to 60 lb. per quarter.

The Romney-marsh is the term applied to the race of heavy sheep kept from time immemorial on the alluvial tract on the southern coast of Kent termed Romney-marsh. The sheep of this rich tract are large, yielding a heavy fleece of long wool. The older Romney-marsh sheep, though esteemed by the butchers, were regarded as being very defective in form; as having narrow breasts, large bellies, and coarse extremities. It is long since they have been crossed by the new Leicester, which had the effect of diminishing their size and lessening the quantity of their wool, but of improving their general form, and giving them a better disposition to fatten. It was found, however, that besides the decrease of weight and deterioration of the fleece, the cross breed was less suited to the cold open pastures of the marsh. They were driven into the ditches by the strong south-westerly gales. The breeders of the Romney-marsh, therefore, now abstain from crossing, and endeavour to revert more to the characters of the original breed.

The Devonshire-Notts formed a race of long-woolled sheep proper to the lower parts of Devonshire. There used to be two varieties, the Dun-faced Nott, and the Bampton-Nott. They formed a clumsy race of sheep, with thick skins, bearing long close wool. They are now nearly extinct in their pure state, having been almost universally crossed by the New Leicester. This crossing has been singularly beneficial, the result being a race of long-woolled sheep of great size and good form. Many of the sheep of Devonshire are now to be ranked amongst the largest in the kingdom.

To these breeds might be added others which may be rather said to have once existed than to be now found. Such were the Old Warwickshire, the wool of which resembled that of the New Leicester, the Old Leicester, which has merged in the modern breed, and the old Teeswater, which in like manner has had its characters entirely modified by the effects of crossing. These last were the long-woolled sheep of the district of the Tees. They were a very large race of sheep, arriving at great weight, and being very prolific of lambs. The wool produced was long and heavy to the fleece. The traces of this breed are now only to be recognised in the flocks of a few breeders, distinguished by the superior size of the animals. The Old Irish breed extended, with some difference of characters, over the whole of the less elevated parts of Ireland. These sheep were of large size, had coarse heads, flat sides, and narrow chests. They have been universally crossed by the New Leicester, so that it is difficult to find an individual of unmixed blood in the whole country.

The New Leicester is frequently termed the Dishley breed, *from having been produced by Robert Bakewell of Dishley, in* the county of Leicester. This gentleman was the son of a considerable farmer, and, about the year 1755, began to turn his attention to those improvements in the form of animals, by which he became so distinguished. The precise steps which he followed in the forming of his breed of sheep are not known, as he chose to observe an entire mystery on the subject, and left not a single written memorial behind him of his curious and important experiments. It has been supposed that he derived some of his first sheep from Lincolnshire, and this is rendered probable by an admission in one of his own letters; but it is rather to be believed, that the Warwickshire and other long-woolled sheep of the midland counties, were resorted to as the chief basis of his unrivalled stock. It may be too, that there was a slight intermixture with the blood of some of the finer woolled sheep, of which the records are now for ever lost. But whatever were the steps which Mr Bakewell pursued, it was by breeding from animals of the form required, until he arrived at the properties aimed at, in the progeny, that he gradually corrected the defects, and improved the form, of the animals. He was well aware of the external characters which indicate a disposition to fatten, and, by a steady course of selection continued during a lifetime, he obtained animals of superior feeding properties to any that had been before cultivated. By constantly breeding, too, from individuals of his own flock, and consequently near of blood to one another, he gave a permanence to the characters of his breed which it retains to the present hour. Mr Bakewell adopted the practice of letting out his rams for the season, and this contributed to the general diffusion of his breed. Successors to Mr Bakewell have continued the same system, and bestowed the utmost care in maintaining the purity of their flocks: and thus from the county of Leicester as a centre, this breed has spread to every part of England where the breeders have thought fit to receive it. It has entirely changed the character of the greater part of the long-woolled breeds of this kingdom, and been mainly instrumental in causing the substitution of long-woolled for short-woolled sheep, which has taken place to a great extent throughout England.

The sheep of the New Leicester breed are inferior in size to the other varieties they have supplanted. The wool is but of moderate quality, and in weight it falls short of that of the larger breeds. The value of the breed, therefore, does not consist in the size of the individuals, or the quality or abundance of their wool, but in early maturity and aptitude to fatten. In these latter properties the New Leicester has not been surpassed by any other breed of cultivated sheep.

The Cotswold sheep, although the inhabitants of low hills, must be classed with the sheep of the plains. They inhabit the calcareous tract of country which forms the east part of Gloucestershire. They are of massy form and bear long wool. The older breed has been universally crossed with the New Leicester, and has been lessened in size, although doubtless improved in form. But the modern Cotswolds are still a very weighty race of sheep. Their wool is longer than that of the New Leicester, but not so fine. They are hardy, prolific of lambs, and good nurses, and the lambs are early clothed with a thick fleece. They have a tendency to accumulate fat on the rump. They are nothing like so perfect in form as the New Leicester, but their hardiness, prolificness and size, give them a claim to attention amongst the superior breeds in this country. The system of crossing with the New Leicester began about 50 years ago; but for a considerable period past, the tendency of breeders has been to preserve the breed from further intermixture, and to revert to the standard of the older race.

The breeds of sheep, then, of this country, may be divided into two classes,—the sheep of the mountains, lower moors and downs,—and the sheep of the plains.

The sheep of the first class have sometimes horns and sometimes want horns. The finest of them have no horns, namely, the Cheviot and the Southdown. One of them, the black-faced heath breed, has coarse wool: the Dartmoor and Exmoor sheep, have long but not coarse wool; and all the others have short wool.

Of the moorland and down breeds, as they may be called, the hardiest is the black-faced heath breed, and this property points it out as the most suitable for a high and rugged country, where artificial food cannot be procured.

The breed next to this in hardy properties, but surpassing it in the weight of the individuals, is the Cheviot. Where the pasture contains a sufficiency of grasses, this breed deserves the preference over any other known to us for a mountainous country.

The next breed meriting extensive cultivation is the Southdown. This breed is suited to a lower range of country than the Cheviot and heath sheep. To the chalky and sandy downs, where it is indigenous, no breed can be better fitted, and it may be carried far beyond these limits; but it is unsuited to the more rough and elevated pastures, to which the black-faced and Cheviot are adapted.

These are the moorland and down breeds, which appear to be the most deserving of cultivation in this country. Of the larger breeds of the plains, the New Leicester is well adapted to general cultivation; and, wherever an improved system of tillage is established, may be introduced.

2. IMPROVEMENT OF BREEDS.

The breed of sheep to be reared in any case must be selected according to the nature of the pastures, and the artificial means possessed of supplying food. If a mountain breed is selected for rearing on a low arable farm, then the advantage is lost which the farm possesses of producing a larger and finer class of animals. If, on the other hand, a lowland breed is carried to a mountain farm, an error of a different kind, but yet more hurtful, is committed; for a fine stock will be ruined if placed in circumstances where it cannot be maintained.

The breed, then, being selected which is the best suited to the circumstances in which it is to be placed, the province of the breeder is to breed from the best individuals.

Disposition to fatten, and early maturity, are the properties most regarded in sheep to be reared for food. But the property of yielding good and abundant wool is not to be disregarded; and there is another property essential in the rearing of this class of animals, namely, hardiness and sound health of individuals.

In the case of the sheep as of the ox, refinement in breeding may be carried too far, and with more danger. By breeding from animals near of blood, the same means exist in the case of the sheep as of the ox, of giving that prematurity of age which produces fineness of the bones, and a disposition to fatten. But it is attended, too, with the same effect, of rendering the animals more delicate, and subject to diseases. It seems a violence done to nature, when carried too far, and the animals show the effects of it by becoming too fine in their skins, by ceasing to produce wool in sufficient quantity, by the females ceasing to yield milk, and by the males becoming at length unable to continue their species.

Whenever, then, the sheep of any flock become too near of blood, the breeders should resort to the best animals of another family, but of the same breed, to continue his stock. This species of crossing is now easy, since there is scarce any of the cultivated breeds of which superior males may not be procured from other flocks. In the case of the New Leicester, so widely diffused and highly improved, no necessity can exist for breeding from animals too nearly allied.

3. Form.

In the sheep, as in other animals, certain external characters indicate a disposition to fatten, and at an early age. Other characters indicate a disposition to produce wool, and the quantity of wool, it has been said, is not to be disregarded in the rearing of the sheep. But the main purpose in rearing the sheep in this country being for food, the province of the breeder is to accomplish this object with as little sacrifice as possible of the secondary qualities.

A property that indicates a tendency to fatten in the sheep as in the ox, is a general rotundity of form and fineness of the bones. The chest should be broad, the ribs well arched, and the back and loins, accordingly, broad, flat, and straight. The sheep, like the ox, occupies, independently of the neck and head, nearly a rectangle, and the larger the proportion of this rectangle which the body occupies, the more perfect is his form as a fattening animal. His body, therefore, should be large in proportion to his limbs, or, in other words, his limbs should be short in proportion to his body; his breast should be well forward, and his belly straight; his head should be small and his ears thin; his limbs to the joint should be fleshy, below delicate and covered with short hair: his skin should be soft and elastic; his wool soft to the touch, thick, and coming well forward to the face, but not covering it: his face and forehead should be covered thickly with short hair, and his eyes, as indicative of health, should be lively.

4. Rearing and Feeding.

In the rearing and feeding of sheep, the system to be adopted must depend upon the nature of the farm, and the kind of stock. The treatment of mountain-sheep in an elevated country is, of necessity, very different from that of the larger sheep on an arable farm. It is the rearing and feeding of the latter which may be first considered.

The female sheep are ready to receive the ram in October, or sooner; but the precise period is determined by the forward condition and constitution of the animals. A medium period is from the 5th to the 10th of October, in which case the ewes will begin to lamb previous to the beginning of March, and the principal period of lambing be in the early part of that month.

To prepare the ewes they should receive good feeding for a time previous to the male being introduced; and, for this purpose, they may be turned upon the stubbles where the young grass is for a fortnight before. The ram is put into the field where the ewes are pasturing, and herds along with them. He covers them as they come into season; and 1 ram is considered sufficient for 80 sheep. In order to show what females have received him, and what have not, it is usual to smear his breast with pigment, which appears upon the fleeces of such ewes as he has covered; and if more than one ram is with the flock, then, by smearing the rams with different-coloured pigments, as red and blue, the progeny of each is known. Such ewes as have not received the ram may be taken from amongst the breeding-stock and fed for the butcher.

Rams are fit to propagate their species in the autumn of the second year. Well-fed females will receive the male even in their first year; but the proper period is in the October of the second year.

The food of sheep is herbage, upon which they feed during summer. In winter, when the pastures fail, the feeding-stock are fed on a full allowance of turnips, or other succulent food; but the ewes are suffered to pasture during the entire winter, and merely receive such an allowance of other food as is required to keep them in condition. During hard frosts and snow, they may receive hay, which may be either given to them from racks, or simply spread upon the ground. They thus pasture in the fields, receiving hay when occasion requires, until within a few weeks of the period of lambing, when they should receive an allowance of turnips, or other succulent food, laid down in the fields where they are pasturing.

When the period of lambing arrives, every vigilance is necessary on the part of the shepherd. He must be at all times at hand to assist the births. He must take his necessary rest only during the day, and for the shortest time possible, when his place can be supplied. When a house is not at hand, covered pens must be erected in the fields, and the ewes, when about to lamb, brought to the pens.

The birth of the young must be assisted, but not precipitately. The proper position of the fœtus is with its head couched between its fore-legs. In other positions the birth is difficult, and it generally becomes necessary to turn the fœtus, which is done by elevating the ewe from behind. Experienced shepherds are acquainted with these duties.

When the young is born, it is to be immediately recognised, and licked by the dam, and assisted to the teat when necessary. When the lamb of any ewe dies, another should be supplied to her; either one of the twins of another ewe, or one that has lost its own dam. Sometimes much difficulty is experienced in getting the ewe to adopt another lamb; and cases even occur, when the ewe, from some unknown cause, deserts her own young. In proportion as the ewes have lambed, they should, if possible, be transferred with their young to a field of new grass.

An operation to be performed upon the lambs is castrating the males which are not to be reserved for rams. This may be performed in a few days after the birth, generally in 8 or 10 days. It is done by the shepherd, with an assistant to hold the animal, and, at the same time, it is usual to cut off a portion of the tail. The operation is performed on lots of the lambs, and not on each singly as it reaches a certain age. It is well that it be performed early, the difficulty and danger increasing with the age of the animal, and that the weather at the time be dry, and, if possible, cloudy and mild.

The lambs continue with the ewes sucking them till the period of weaning, which generally takes place by the middle of July. Weaning is simply performed by removing the young from their dams, and keeping them for a time so far asunder that they may not be disturbed by their mutual bleatings.

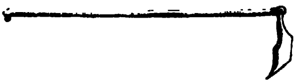
When the lambs are weaned, the ewes should be milked, for the purpose of relieving their udders and running them dry by degrees. Three milkings will generally suffice, though, should any particular cases require more, it is the province of the shepherd to attend to them. Supposing the lambs to be weaned in the evening, the first milking may take place in the following evening, or in 24 hours; the next at an interval of 36 hours; the last at an interval of 48 hours. When the ewes are to be milked, they are driven into a narrow pen, the milkers, with pails, milking the ewes from behind; and on each ewe being milked, she is turned round in the pen by an assistant, the milkers continuing their work until the whole are milked.

After being weaned, the lambs receive the name of hoggets, or hogs, the rams being termed tup-hogs, the castrated males, wether-hogs, the ewes, ewe-hogs.

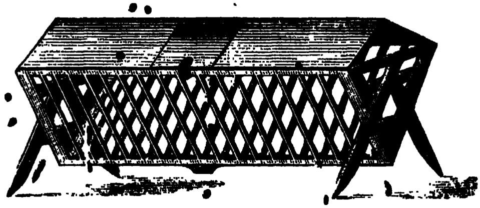
The wether and ewe hoggets are now pastured together for the remainder of the season. When winter approaches, or rather when the pasture fails towards the end of October or beginning of November, the hoggets, male and female, are to be put on a full allowance of turnips. The turnips can either be conveyed to the ground where the animals feed, or the simpler process be adopted of penning the sheep upon the turnips.

When the sheep are penned upon the turnips, they are confined to a given space, generally sufficient for them to consume in one week. The temporary fences used for penning them consist either of wooden hurdles, or nets, the latter being the most economical and convenient. In this space the sheep consume the turnips, and when they have eaten them close to the ground, the remaining portions of the bulbs are picked up by means of the hoe, Fig. 193, so that the sheep may be enabled to eat them wholly up.

Fig. 193.



When they have consumed one space, the pens are shifted to another, in such a manner as to leave the ground already



cleared open to the animals for walking over and resting upon. A rack, Fig. 194, should be placed in the field with hay.

Sometimes when young sheep are penned till late in spring, they find difficulty, from their teeth becoming loosened, in eating the turnips. In this case, the turnip-slicer (Fig. 47 or 48) may be employed, and then the sheep may be brought from the turnip-field, and have the turnips laid down to them in a field of dry sward.

The young sheep or hoggets are in this manner fed on turnips till the grass is ready in spring. This will be early in April, or, in the southern parts of the country, in March; for sheep do not require the same full herbage as cattle, and may therefore be turned out at an earlier period to the fields.

Should the turnips fail before the pastures are ready, then the young sheep are to be carried on by substitutes, as hay, or even corn. It is rarely, however, necessary on a well-ordered farm to resort to this costly species of feeding; yet, when necessary, it must be done, since this inconvenience is less than the evil of suffering the stock to lose condition.

The period of shearing sheep depends upon the forward condition of the animals. When fat, the old wool begins to come off more early than when they are less forward. Good conditioned sheep may be shorn in May, but always early in June; the precise period being denoted by the state of the wool, which comes readily off when plucked, and which would fall entirely off were it not shorn.

About eight days previous to shearing, the sheep are driven to a pool, if possible in a running stream, and three or more persons are to stand in this pool. The sheep are brought forward to a pen on the bank, and lifted into the pool one by one. The first of the persons in the pool seizes the sheep by the wool; and keeping it on his back, plunges it well from side to side. He passes it on to the person next in order, and he in like manner plunges the animal in every direction. This person then passes it on to the third, who examines the fleece as well as circumstances will allow, plunging the sheep at the same time, and thus finishing the operation. The animal is thus passed through the hands of three persons, and sometimes more; but the last should be a trusty person, such as the shepherd himself, whose duty it is to see that the fleece is completely washed and freed of sand and impurities.

This description has a reference to young sheep or hoggets, whose management we are now considering; but the same method is applicable to all the sheep upon the farm, young and old, with this difference, that the ewes, which are at this period suckling their young, have the lambs separated from them during the process of washing.

The sheep being washed, are driven to a clean pasture, and when the fleece is dry, which it will be in a few days, if the weather is good, the sheep may be shorn; but it is better that seven or eight days should elapse before shearing them, in which case the yolk of the wool is renewed.

When the sheep are to be shorn, they are driven to a pen or other enclosed space, and brought one by one to the shearers. The sheep to be shorn is first placed upon his rump, and the shearer, with the shears (Fig. 195), beginning at the neck, clips in a circular direction down the belly towards the back. The animal is then laid on his side, and kept down by the leg of the shearer, who clips the fleece all round to the back. Turning the animal on the other side, he clips in like manner round to the back; then raising the sheep, he clips the part of the fleece not yet cut away, and so lets the animal go, taking care that it shall not entangle itself with the fleece. The fleece, as soon as it is shorn, is taken away by an attendant, spread out, neatly rolled up with the inner surface outmost, and then deposited in some dry place, until it is packed in the wool sheets.

Fig. 195.

When the animals are shorn, they are frequently marked with a stamp (Fig. 196), dipped in boiling tar, to distinguish the kinds and ages of the sheep. This kind of mark, though convenient, is injurious to the wool.

Fig. 196.

After the operation of clipping, the young sheep are termed shearling sheep; the castrated males, shearling wethers; the females, shearling ewes; the rams, shearling tups or rams. But it is common to apply to them at this period the following terms:—The shearling wethers are termed dinmonts; the females are termed gimmers; and the rams are still termed shearling rams; and these names the animals retain until they are shorn of their second fleece in the following year.

The shearling ewes or gimmers are, after being shorn, kept at grass for the remainder of the season, and they receive the rams in October in the manner described.

The shearling wethers or dinmonts are soon after shearing fit for the butcher. They are then about one year and three months old. If of the Leicester breed, they will weigh 16 lb. or 18 lb. the quarter, and their fleeces will weigh 7 lb. each or more.

But should the pasture be inferior, the breed bad, or the stock not in sufficient order, or should the state of the markets render it inexpedient to sell, then the dinmonts may be kept upon the farm for one winter more. In this case they are pastured precisely as when they were hoggets during the remainder of the season; and when in autumn the pastures again fail, they are penned on turnips, and treated in the same manner as in the previous winter.

The dinmonts are frequently sold fat before they have completed the entire winter's feeding. But it is more common to keep them during the winter on turnips, to put them upon good and early grass in spring, and to dispose of them after they are shorn. They are then two years and two or three months old, and have yielded two fleeces to the breeder. They will weigh at this age from 25 lb. to 30 lb. the quarter or more, and their fleeces will weigh about 8 lb.

These and other sheep, after they are shorn of their second fleece, are termed two-shear sheep: the males not castrated are simply tups or rams; the males castrated are wethers, and the females are ewes. It is more profitable to be able to feed off sheep when shearlings than to retain them till they are two years old. The former is the perfection of feeding; but it is a perfection attainable on every arable farm in this country on which turnips can be raised, and a superior breed of sheep maintained.

In the practice of the farm, then, the male sheep are disposed of either after having yielded one fleece, or after having yielded two fleeces. Such of the ewes as are reared on the farm, but are not to be employed for breeding, may be treated in the same manner.

But with respect to the ewes upon the farm kept for breeding, it is necessary, after they have borne lambs for several years, to dispose of them, and to supply their place by younger ewes reared upon the farm. A certain number of gimmers being each year added to the breeding stock, an equal number of the oldest ewes are disposed of, and thus the number of breeding sheep is maintained.

And not only are all ewes which have borne the required number of lambs to be disposed of in this manner, but all breeding sheep, of whatever age, that are not healthy, or that are of a defective form, and their place is to be supplied by the younger and better stock reared upon the ground.

These, then, have been the principal points of practice in the management of a sheep-stock reared upon the farm: The female stock, like the males, were suckled by the dams till July; they were then weaned, and pastured with the wether-hogs during the remainder of the season, when they were put together with the wether-hogs on turnips before winter; they were fed on turnips till April, when they were turned out to pasture along with the wether-hogs; early in June they were clipt; in the month of October they were joined to the rest of the ewe stock, supplying the place of the older ewes that had been disposed of; and after this time they were treated in all respects as breeding ewes, and kept upon the farm till they have borne lambs for three or four years. The males, it has been seen, were castrated a few days after birth,—were weaned in July, when they received the name of wether-hogs,—were pastured during the remainder of the season, and were then, together with the ewe-hogs, penned on turnips; in the following April they were put on grass, and by the beginning of June they were washed and clipt: they then received the name of dinmonts, when they were fat, and ready to be sold as soon afterwards as convenient: Or when, from the deficiency of feeding or other cause, they were not then ready for the butcher, they were again pastured during the summer, a second time penned on turnips, and generally pastured till they were clipt the second time, when they were wethers and in high perfection with regard to growth and fatness.

Sheep, especially when fat and loaded with wool, are often unable to rise when they have fallen upon their backs in any hollow place, and they will perish if not relieved in time. To guard against these and all other accidents, sheep must be regularly tended. They must be examined at least twice in the day; they are to be cleaned when necessary, by cutting off clotted wool, and above all things they are to be guarded against the attacks of maggots. In the latter case, a decoction of tobacco mixed with spirits of tar, and in some cases a solution of sublimate of mercury, are the remedies commonly employed. Their heads are frequently injured by the attacks of flies; for which a little tar spread upon the wound is the most frequent and the best remedy.

In the whole treatment of sheep, gentleness is of great moment. The worrying and harassing of them by dogs is never to be thought of. In upland pastures the faithful dog is essential to the shepherd; in an enclosed country the necessity for employing him is greatly lessened, and he is always to be used with temperance and humanity towards the flock.

The treatment of a lowland stock has been described, where the breeder is likewise the feeder; but sometimes the object of the breeder is not to feed the stock which he rears, but, after having brought it to a certain age, to dispose of it to others, who will feed it.

Sometimes, on the other hand, the design of the farmer is not to breed sheep, but to buy them from others whose interest it has been to rear and not to feed them. The effecting of these sales, on the one hand, and the making of these purchases on the other, constitute one of the branches of farming as a

business. But it is a branch which
but must be learned by practice.

One of the branches of sheep-farm
is likewise the feeder, is the rearing of lambs and selling them when fattened. The lambs are fattened by the milk of the mothers, and are merely disposed of when they are ready for being killed. The feeding of the lambs in the house for early consumption, is also practised, and in some parts has been brought to a system. This branch of management need not be described. The sheep of the Dorset breed are valued as being the best suited to yield early lambs in this manner.

Grass in summer and turnips in winter, with a little hay for the ewes, have been spoken of as the food of sheep. The basis of this system is the turnip crop. But, in certain cases, this mean of support may fail or be wanting, and it then becomes necessary to resort to other substances. Potatoes, mangel-wurzel, and other roots, may be eaten by sheep as well as by oxen; and cabbages and rape are perfectly suited to the purpose of feeding them.

All kinds of farinaceous food are consumed by sheep. When corn is given, it is the common practice to lay down the sheaves unthrashed, when the sheep readily separate the grains from the straw.

Brewers' grains may be given to sheep; and they will consume this nourishing substance readily. Oilcake, too, is well calculated to fatten sheep, and may be used occasionally where cheaper methods of carrying on the stock are wanting.

Attempts have sometimes been made to soil sheep during summer, in the same manner as horses and oxen. This practice is common on the Continent, where the sheep are kept in pens and littered; but it has made no progress, nor is it likely to make any progress, in England, so much more simple and economical is the turning out of the animals to pasture in the fields.

Besides common food, there is a condiment, Salt, of great importance to sheep, as to all domestic animals, but which is too much neglected in the rural economy of this country. If laid on flat stones or in troughs, the animals will quickly find their way to it, and will be seen to wait for their daily portion of salt with as much eagerness as for their periodical supplies of food.

I have spoken of the management of a lowland breed of sheep. It is necessary to consider also the treatment of the animal under circumstances entirely different; that is, when reared and pastured in a country where cultivated food is either wanting or to be procured in limited quantity.

The Cheviot sheep are reared in an elevated country. But in the places where they are produced, turnips and the cultivated grasses may generally be supplied in certain quantity.

In the rearing of this breed, the rams are usually put to the ewes from the middle to the 20th of November, so that the lambs shall begin to drop about the first of April. The ewes generally receive no further feeding during the period of gestation than hay in falls of snow. This may be supplied to them from racks, or simply laid upon the surface of the snow. The ground is frequently covered with snow for six weeks; but it is sometimes covered for twice that period. During the winter, therefore, a store of hay should be in reserve for three months' consumption, and this may be calculated at the rate of 1½ lb. for the ewes and older sheep, and 1 lb. per day for the younger sheep. Should the winter be mild, what is left remains till the following season.

Where turnips are raised, these are given also to the breeding stock. The ewes receive them during falls of snow, and in an especial degree when the lambing season arrives and during its continuance.

When both hay and turnips are to be supplied, it will be proper either to give them at the same time, that is, a portion of hay and a portion of turnips each day, or to begin with hay and end with turnips; for to begin with turnips and end with hay is to cause the sheep to pass from succulent food to one which is less grateful, so that a time elapses before the animals are reconciled to the change. But when turnips are given, and hay supplied at the same time, the sheep take to this variety of feeding very readily.

The process of lambing in these high districts demands the utmost vigilance of the shepherds. They must never be absent night or day, but relieve one another, and inspect the flock at short intervals, so as to assist the parturition of the ewes when necessary.

Sometimes the lambs at their birth are so weak that they cannot rise to their teat, and thus perish or are forsaken by the dams. The shepherd assists them in such cases, and frequently takes the ewe with her young to a house or place of shelter, where they can be attended to. When the ewes have twins, and thus have two lambs to nurse, it is usual to give them a more liberal supply of food. For this purpose it is convenient to have an enclosure of early grass near the place of lambing or the shepherd's cottage, to which ewes with twins, such as have too little milk, and such as are sick or infirm, or from any cause require more attendance than the rest of the flock, may be taken. Though various ewes produce twins, it is regarded as a favourable circumstance in the case of this class of sheep when one lamb can be reared for each ewe of the flock. It is well when 19 lambs can be reared for every 20 ewes.

As soon as the weather is favourable, after a considerable number of the ewes have lambs, they are collected into a fold, and all the males castrated, except such as are reserved for rams: and the sooner the operation is performed after the lambs are a few days old the better.

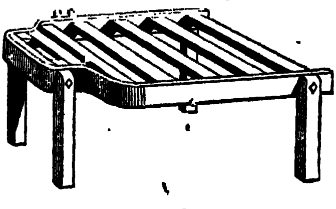
When the period of shearing arrives, which is known by the wool being fully grown, the sheep are washed, sometimes by men standing in the pool, who wash each sheep separately, in the manner before described; or, when the flocks are large, by causing them to swim two or three times through the water to the opposite bank. After being washed, they are kept as much as possible on ground where they are preserved from rubbing on banks, or otherwise soiling their wool. In two days, if there be no rain, they may be shorn, but it is better to wait seven or eight days. The wool is shorn in the manner before described, and stored in a proper place till packed in sheets. As soon as each sheep is shorn it may be marked with a stamp dipt in boiling tar. The mark is made on different parts of the body, as the near shoulder, the far shoulder, the near rib, the far rib, so as that the different kinds and ages of the sheep can be known at a glance.

About the middle of July the lambs are weaned, when such lambs as are to be disposed of are separated from the remainder and sold. The lambs, now hoggets, are put on such good pasturage as the farm affords, and supplied, if possible, with turnips throughout the winter, at the rate of a cart-load for 7 or eight scores in the day.

Some farmers still milk their ewes for a few weeks; but the more approved practice is to milk them only for a few days, merely to relieve the ewes of their milk by degrees.

Before winter, it is a general practice, the utility of which is experienced in a very elevated country, to smear the skins of the sheep with a mixture of tar and butter. The practice indeed is found to deteriorate the wool, by staining it, and rendering it unfit for receiving the brighter colours in dyeing. It is found, however, conducive to the health of the stock in an inclement country, destroying vermin, of itself an important object to the health of the sheep, and acting to a considerable degree in defending the animals from cold and moisture. The mixture is prepared by boiling the butter, and mixing it with the tar, and sometimes by adding some milk; the proportions employed differing according to the practice of different farms and districts. In some places 6 lb. of butter to 1 gallon of tar are considered sufficient for 20 sheep. The period of smearing is the end of October or beginning of November, that is, before the rams are admitted to the ewes. The method is, to place the animal upon a stool, Fig. 197, to separate the wool, and with the end of the finger to smear the skin longitudinally from head to tail. One man will smear from 20 to 25 sheep in a day.

Fig. 197.



It is a general error on merely stock farms to plough up, too much of the land for crop, or to intersperse the cultivated land with the range of the sheep pasture. The object of tillage on such farms is to raise turnips and clover-hay, for keeping the stock throughout the winter months, and, this being attained, the farmer ought rarely to carry his system of tillage further.

In many cases, indeed, the farmer of a mountain farm has also a sufficient quantity of lowland ground to combine the practice, both of rearing sheep and feeding them. This, when it occurs, is beneficial; but when it does not occur, the proper occupation of a mountain farm is to rear sheep, and not to feed them; and the general principle of management is to sell the sheep which are reared to the feeder as soon as they have come to tolerable maturity, that is, either after the first winter, when hoggets, or after the second winter, when dinmonts.

Reared in yet more elevated districts than the Cheviot, are the Black-faced heath sheep. These are the hardiest of all our races of sheep, and in the parts of the country where they are principally cultivated, they must depend chiefly or entirely on the natural herbage of the farm.

The rams are generally put to the ewes after the middle of November, and one ram is assigned to sixty ewes or less. The lambs intended for wethers are castrated somewhat later than the other sheep: they are weaned late in July, and the ewes milked sometimes for a few weeks. The sheep are shorn from the end of June till the middle of July; and when they are to be washed, they are driven to a pool or deep stream, and forced to leap from the bank. This being a very wild race of sheep, the same delicacy of management is not necessary or practicable as in the case of the more docile breeds of the plains. They are shorn in the same manner as the other sheep; and opportunity is then taken to place upon them their distinguishing marks. In all cases they should be smeared; for though, as in the case of the Cheviot sheep, the wool is injured by the process, this is more than compensated by the benefits resulting to the flock.

The food of these hardy sheep is in summer and winter the same; and all that can be generally done is to supply them with some coarse hay during long-continued falls of snow. They are sold at the ages which suit the nature of the farm and the convenience of the breeder.

The management of the other kinds of down or moorland sheep need not be detailed. These breeds are generally in low situations, where the difficulty of procuring food is comparatively little. The nearer the management of this class of sheep approaches to that of the larger sheep of the plains, already described, the more perfect will it be.

5. Diseases of Sheep.

The diseases of these valuable creatures are sometimes of a very formidable nature, and baffle all the means of remedy which are known to us. Of these diseases the most dreaded is *rot*, which often extends over whole districts of a country.

It is known that this disease is favoured or produced by a humid state of the soil and atmosphere. It is in wet seasons that it prevails the most, and is the most fatal. By draining land the tendency to it is lessened or taken away. Often sheep are rotted by pasturing on the wet parts of the farm, whereas if kept from these parts they remain free from disease. Nay, a single sheep that has a disposition to pick up its food in moist places will die, while the others will not be affected.

The animal affected does not all at once show symptoms of disease; for sometimes it remains a considerable time in apparent health, and long after it has been removed from the place of infection, droops and dies. Sheep are every year purchased in seeming health, and yet after a time they are found to be affected. A moist and even luxuriant autumn is dreaded above all things by the owner of sheep; for the seeds of infection are then often spread to appear in the following spring, or after the lapse of a longer period.

The signs of rottenness in sheep are familiar to all shepherds. The animal becomes emaciated, its eye becomes dull and glassy, a black purging generally takes place, the wool, on being pulled, comes readily away from the skin, the breath becomes fetid, and the urine is small in quantity and high coloured. As the disease proceeds, the skin is marked with spots, and the emaciation increases continually, until the sheep dies. In short, the term rot expresses truly the state of the animal. The disease proceeds with various degrees of rapidity; sometimes it attacks the entire flock suddenly, and sometimes its progress is gradual, and it affects only a given number of individuals. Graziers often avail themselves of the period of the animals beginning to decline to rid themselves of an infected stock. During the first period of being tainted, the sheep have frequently a strong tendency to feed, and if killed in time the flesh may not be perceptibly affected.

In all cases of rot the disease is accompanied by a morbid state of the liver. During the progress of it, the fluke, a small animal, *Fasciola hepatica*, appears on the parts connected with the liver and the gall-bladder. At first the number of these creatures is small, but as the disease advances they increase, and before death are generally very numerous. In the last stage of the disease they have extended to the stomach and other parts.

Frequently the disease terminates favourably, the inflammatory action going off without destroying the parts. But even in this case, the taint is rarely removed, and years afterwards, when the animal has been fattened and killed, the liver has been found to be diseased, the flukes being in great numbers.

The best preventive of rot is to render the soil dry; hence on all sheep pastures the importance of draining. But should the disease, in spite of all precautions, appear, then we should, without loss of time, remove the sheep to a drier pasture, and supply them liberally with proper food. It is only, however, in the early stages of the disease, that a change of food will usually avail. If the disease has proceeded to a considerable extent, even though it should not have evinced itself by any great change in the external appearance of the flock, the aniwith which they can be supplied.

Of all the medicines that have been proposed for this fatal disease, salt alone is that whose virtue has been established by any satisfactory testimony. The beneficial effect of salt in the prevention and even cure of rot has been confirmed by the observation of farmers in this and other countries.

Salt indeed will not in all cases prevent or cure the disease; for sometimes the tendency to it from particular causes is too strong to be counteracted, and, when it has once attacked the flock, too violent in its progress to be arrested. But though salt is not a specific, it is the best means of remedy with which we are acquainted.

If salt be placed near the animals in troughs or on flat stones, they will eagerly lick it, and when disease threatens them, it may be given to them in any quantity in which they will consume it; for it is then seen that they are obeying a natural instinct in having recourse to the remedy; and in a wet season, when disease may be apprehended, no one should grudge the trouble of so cheap and simple a precaution.

Much has been written upon the subject of this disease, but all that has been written has nearly left us where we were with regard to the remedy. It had been long known that wetness of the soil, however produced, gave rise to rot; that the best preventive was pasturing on dry ground, and giving sufficient food, and that the best remedy where disease appeared was a change of pasture. To these results of old experience is to be added, the using of salt.

Another disease, arising from a different cause than the rot, but like it ending in emaciation, and the death of the animal, is provincially termed *pining*. This disease is accompanied by a costive state of the animal, whereas the rot is never accompanied by costiveness; and in the rot the liver is always affected, while in the pining the liver is sound.

This disease seems to arise from the want of exercise, and from the animals feeding on very dry pastures. Before the extensive draining of the pasture-lands, where it is now [illegible] the disease was unknown. The rot was then common; but with the draining of the lands the rot disappeared; and this new disease took its place. The former practice of management in the districts where the disease now prevails, was to keep the sheep in flocks, which were moved about along their allotted range of pastures. They are now, under a more approved system of management, suffered to spread over a large extent of pasture; and thus they are not obliged to take exercise, but are allowed to feed more on a given spot of ground.

A change of place and food is the preventive or the remedy; and if a change of food is resorted to in time, it is generally sufficient to arrest the progress of the disease. Even a removal to a fresh heath will sometimes accomplish the purpose, but the proper and effectual remedy in all cases is a change to a more rich and succulent pasture. The disease is sometimes very fatal, destroying entire flocks like a pestilence.

Sheep are subject to a long and frightful train of inflammatory diseases. In all such cases, however they may affect the animals, bleeding should be at once resorted to, as the only mean of subduing the disease, and giving a chance of safety. The eye-vein is that usually opened in bleeding the sheep; but all shepherds should be taught to bleed from the jugular vein, as being the most suitable. The quantity of blood extracted must vary with the age and strength of the animals. The rule in the case of the sheep as in that of the ox, is to bleed freely. The process may be continued until the pulse itself is affected, when it must be instantly stopped. Purgative medicines, too, ought to be given to the sheep, in the case of this class of diseases, and of these the most approved are, Epsom salt, in the proportion of from 4 to 6 oz., and about half that quantity, or a little more, of Glauber's salt. Common salt is often applied in country practice with the effect desired. On the part of shepherds, it is to be observed, there exists a prejudice against the administration of medicines to sheep, doubtless from their having observed the little effect usually produced. But this prejudice should not be permitted to operate where the lives of sheep are in imminent hazard, as is the case in all inflammatory diseases. It is beyond a doubt that by prompt bleeding, and the judicious application of purgatives, the lives of many thousands of these valuable creatures may be yearly saved to this country.

Amongst imflammatory putrid fevers to which sheep are subject, one, termed braxy, is very destructive in various parts of the country. The progress of this disease is very sudden and violent. Of the remedies to be employed, bleeding and purging are plainly those which the nature of the disease points out. This disease seems generally to be caused by bad food, and the most efficient preventive is known to be good feeding. Turnips or other succulent roots given to young sheep feeding on natural pastures are always beneficial; and it is to be observed, that in proportion as the treatment of sheep in a country has improved, this dangerous malady has diminished.

Diarrhœa and dysentery are diseases of sheep. Diarrhœa is frequently produced by too sudden a growth of grass in spring, and it most frequently affects young sheep. It may be generally cured by removing the animals to drier pasture; and a little corn may be always given with good effects.

Dysentery is a more serious disease, and is often very destructive. In this disease, bleeding is plainly required to subdue the inflammation, and purging to carry off the peccant matter in the intestines. Hay may be offered and a few sheaves of corn laid down, and the use of mashes will in an especial manner be found beneficial.

Sheep are liable to various cutaneous diseases. The principal of these is termed scab; and it is indicated by extreme itching and eruptions of the skin. When introduced into a flock it may be attended with very serious effects, unless checked by efficient remedies.

The most common remedy for the disease is sulphur mixed with some unctuous substance to fix it on the skin. One of the best receipts perhaps is a decoction of tobacco and spirit of turpentine, with the addition of a little soft soap and sulphur vivum. The decoction of tobacco may be obtained by boiling the tobacco in brine or salt water. The liquid when prepared is applied from a vessel like a teapot with a spout, or from a bottle with a quill passed through the cork. A person lays the wool back in lines so as to expose the skin, and pours out the liquid along the lines upon the skin. But when the distemper is very violent, a mercurial preparation may be required. This is now to be obtained in apothecaries' shops under the name of sheep-ointment. It is made in balls, and when used is dissolved in oil, and applied to the skin of the animal.

Sometimes infected sheep will find their way into the best managed flocks; but every care must be taken to keep the disease from breaking out, or to cure it as quickly as possible when it appears. The infection of a diseased flock is left behind it upon the hedges and pasture-fields, and therefore precaution is to be used before a fresh flock is turned into fields where infected sheep had been recently feeding.

Another disease of sheep is the foot-rot, which is an inflammation of the foot, followed by an ulceration and destruction of the hoof. The disease chiefly prevails in wet seasons, or in soft grounds. It is a very painful disease, causing the entire lameness and loss of condition of the animal. Certain grounds are noted for communicating the foot-rot; and as it appears amongst the pasturing stock season after season, such grounds are commonly said to be infected with the foot-rot. The opinion that it is of a highly infectious nature is universal amongst farmers and shepherds. But however circumstances may seem to favour this opinion, some have conceived that it is more consistent with effects observed to regard it as connected with the state of the pasture-grounds. Yet it is difficult to resist the evidence, that, having been produced, it is conveyed to others of the flock by contact with the ulcerous matter of the diseased foot.

Although painful and destructive to the good condition of the animal, this disease is not absolutely fatal, except under entire neglect, in which case the animal becomes unable to seek his food, crawls upon his knees, and, worn away by exhaustion, perishes. But if early attention be paid, the disease admits of remedy. In the first place, let all the infected part of the hoof be pared away, and the ulcerous matter removed, and then let the foot be washed with soap and hot water, and let the surface be dressed with some caustic, of which the best is muriate of antimony. In incipient cases, by simply paring the hoof, and cleansing it with soap and water, and then dipping it in boiled tar the progress of the disease will be arrested.

The next disease to be mentioned is of frequent occurrence. This is hydatids, staggers, or water-in-the-head as it is frequently termed. The cause of this disease is a parasitic animal, a hydatid, which is found in the brain of sheep. It enlarges in size, and, if not removed, ultimately destroys the animal. This creature when distended with fluid resembles a round sac filled with water; and hence it was long supposed to be water, and the disease, in consequence, termed water-in-the-head.

When the hydatid is in the brain, the animal affected shows great symptoms of distress; he leans his head to one side, mopes by himself, continues turning round, and finally dies. The remedy for this disease is to reach the hydatid, and to extract it, or at least to perforate it in such a manner as to destroy its vitality. When it is situated at the surface of the brain, the part feels soft, and it may be reached by a sharp instrument, as a common awl or gimlet, or the hydatid itself may be extracted. This may be done by the trephine. Shepherds perform the operation in a rude manner by a sharp knife. A small portion of the skull is so cut, as to be raised up like a lid. The hydatid being exposed, is pulled out by pincers, and the fluid absorbed by a sponge or piece of linen. The skull is then replaced, and dressed with common tar put upon a piece of soft leather.

Often the hydatid may be reached by a wire thrust up the nostrils, and it is remarkable that this operation frequently succeeds in the hands of shepherds.

Sheep are liable to the attacks of various animals. One of these, a species of aphis, termed the sheep-louse, is very common, and chiefly prevails where the sheep are in an unhealthy condition. It is of a flat form, and attaching itself to the throat and other parts, occasions much irritation. Tar, turpentine, or tobacco liquor, are the substances chiefly used to destroy this animal, and any simple mercurial preparation is effectual.

But the most pernicious enemy that attacks sheep is the common sheep maggot, the larva of a species of flesh-fly. The fly having deposited her eggs on the skin of the sheep, the larvæ are hatched in great numbers, and grow with amazing quickness. They commonly appear about the root of the tail, or wherever filth has allowed the fly to attach her eggs, and thence they spread over the entire body, consuming the skin, and eating into the flesh. The sheep, when attacked, manifest a strong sense of suffering. They frequently run with violence, until at length, overpowered and exhausted, they lie down and perish.

It is in moist and warm seasons of the year that the sheep-maggot is chiefly produced. Constant vigilance is then demanded on the part of the shepherd, so that all foulness of the wool shall be clipt away; and the sheep must be daily inspected, lest this dangerous enemy establish itself. The maggot is effectually destroyed by a solution of corrosive sublimate, and in its early stages by less potent applications, as by urine and lime.

We must remember that the sheep, in his domesticated state, is yielded up to the care of man; his natural instincts are blunted, and he is unfitted to those means of preservation which in his wild state he might possess. He is the prey of a multitude of enemies, against which he has no defence; and the more artificial his condition is, the more is he dependent on our care.

6. Wool.

Hair is an appendage of the skin of the mammalia. It consists of fine filaments growing from beneath the skin, to which it serves as a covering; it is nearly the same in its chemical composition as horn and feathers: it is kept flexible and moist by an oily secretion from the skin; it is furnished with bloodvessels, like all the other organs of animals. Being intended chiefly as a covering to the animal, it abounds the most under those circumstances where it is most required. Quadrupeds are more or less covered with it, and for the most part in the greatest degree where the cold is the greatest. Man is slightly supplied with this universal defence; but he is enabled, by his reason, to adapt the hair of other animals to his use.

When the hair of animals is very thick and strong, it forms spines and bristles; when more fine it forms hair commonly so called; when it is fine, and at the same time curled, it is termed wool. It is this curling property of the wool which renders it more suitable than any other species of hair for being woven into cloth. The fur of animals consists of a mixture of hair and wool, but the latter is often in very small quantity. The wool principally used for the purpose of forming cloths is that of the domestic sheep; and we know that this substance has been so employed from the earliest records of the human race. But the wool of various other animals is applied to the same purpose, as of the camel, the lama, and the goat.

Wool frequently loses its curling property, and passes into hair. In the warmer regions the fur of sheep is more hairy than in the colder, apparently because a less thick and matted covering is required for the protection of the animals. Hair also is found, and sometimes in large quantity, intermixed with the wool of sheep in cold and temperate countries. This intermixture of hair unfits the wool for many manufactures, and it is a process of art to separate it from the wool." By neglect in the treatment of the animal, the proportion of hair increases; by care and more complete domestication, the quantity of hair diminishes.

The wool of sheep, like the hair of other animals, is periodically renewed, the older hair falling off, and a new growth taking its place. In the case of the sheep, this renewal of the wool usually occurs once in the year, and at the beginning of the warm season. It is at this period that we anticipate the natural process by shearing or cutting off the external part of the fleece. In some countries the fleece is not shorn, but is pulled off: and in certain conditions of climate and the animal, the wool remains for more than one year. This is especially observed in the Merino. The manner in which the wool is renewed seems to be by a fresh growth from the same roots, and by the old portion breaking off.

Wool, like every kind of hair, grows quickly when cut. We may shear our sheep, therefore, more than once in the year, and the wool will grow again. But, in this country, it is never thought expedient to shear the wool more than once in the year, and the proper period is always when the old fleece is about to fall off, that is, at the beginning of summer. The precise time is very much dependent on the condition of the animal. When fat, the wool tends to fall off more early than when the animal is lean. Frequently disease, and especially disease of the skin, causes the animal to lose its fleece.

The wool of lambs is sometimes shorn, but this is a practice not to be followed in a cold climate. The sheep of this country ought never to be shorn until the second year of their age.

The wool of sheep is sometimes black or brown, and the wool of all the less cultivated animals tends more or less to a dark colour. Some of our sheep, even of superior breeds, have black faces and legs, as the Southdown; and, in all these breeds, there is a tendency to a mixture of black wool with the white. This is an imperfection in the wool, the black piles not being fitted to receive the dyeing colours.

From notices in ancient writers, there is reason to believe that the former colour of sheep was more frequently black or brown than it now is. But if the least attention were paid to the choice of rams, it is easy to suppose that the white colour would ultimately prevail in the domestic sheep of almost all countries; and, from the earliest times, it would be known that black wool was not fitted to receive those beautiful colours which so much please the taste even of the rudest nations. But, in this country, although we have frequently sheep bearing black wool there is no inducement to propagate the peculiarity in the race, and hence black rams are never used.

Wools are distinguished from one another by the length, which is termed the staple of the wool, and by the fineness of the pile or filaments.

In this country, the length or staple of the wool is an important distinction, because it is this which, in a great measure, fits it for a certain manufacture. When the wool exceeds 3 inches in length, it is termed long wool; when it falls short of 3 inches it is termed short wool. The long wool is chiefly applied to the manufacture of worsteds; the short wool to that of woollen cloths. These two kinds of wool are also distinguished by the peculiar manner in which they are prepared for being spun into thread.

The long wool, which is employed for the fabrication of worsteds and other fabrics, is passed in a peculiar manner through combs, with fine steel teeth. The design in this process is to assort and lay together the filaments of the wool somewhat in the same manner as in the case of flax, previous to the process of spinning. That wool may be suited to this operation, it must have a considerable degree of length as well as of strength of pile, so that it shall not be broken when passed between the teeth of the comb. It is the long and stronger wools that are usually treated in this manner, and hence the long wools of this country are familiarly termed *combing* wools.

The wools, on the other hand, intended for the manufacture of woollen cloths, undergo an entirely different preparation previous to being spun. They are not kept entire and assorted in lengths, but are broken into minute pieces, and mingled together in every direction. This is done by the operation of what is called *carding*.

Upon a board, let it be supposed, with a handle attached, is fixed a great number of crooked wires or teeth bent in one direction. These are partially filled with wool. Another board or card of a similar kind is then pulled, so that its teeth shall pass through amongst the teeth of the other; and, by the repeated action of these two cards, the wool is broken into minute pieces, which, from the crisping or curling property of the wool, hook themselves together, and, by a peculiar art, are formed into long rolls, or rovels as they are technically called. These rovels, consisting thus of the minute and broken parts of the wool hooked together, are in a state to be spun, and may be said to form the rudimental thread. This is the process termed carding, which on the great scale is performed by machinery; and the short and more delicate wools being suited to this process, they are accordingly termed *carding* wools.

We have thus two classes of wool; the long wool, also termed combing-wool, used for the manufacture of worsteds; and the short wool, also termed carding-wool, used for the manufacture of cloths.

But, by improvements recently made in the machinery for the woollen manufacture, wool that was formerly deemed only suited for carding, may now be prepared by the comb. Thus, the Southdown wool, which was entirely appropriated to the card, is now likewise prepared by the comb, and consequently may be employed for a different class of fabrics. On this account, short wool is not now entirely synonymous with carding wool, although it may be always prepared by that means.

Wool, subjected to the carding process, ought to possess certain qualities. 1*st*, It ought to have that peculiar crisping or curling quality which distinguishes wool from hair, so that when broken into minute pieces, each part may curl at its extremities, and all the parts be hooked together, and form what has been termed the rovelling; 2*d*, It ought to be free of hairs, for these, not possessing the curling property, will not amalgamate with the other parts, and so will injure the future fabric.

Wool ought to be soft to the touch and pliable, the filament, too, ought to be regular, that is, it ought to be cylindrical, or rather a scarcely perceptible cone from the root to the extremity. Further, it ought to have that peculiar property to which the term felting has been applied.

This latter property consists in a tendency in the filaments to unite or adhere when pressed together. We avail ourselves of this property of hair in the manufacture of hats, which are formed of the wool and down of animals. By pressure and moisture, all the parts adhere so closely as to become a compact mass. The same property is applied in the manufacture of cloth, by pressure and moisture, after the cloth is woven, by which means the filaments and threads contract, adhere closely together, and do not unravel when cut. This is a property of great estimation in woollen cloth, and certain wools possess more or less of this property of felting, or cohering together.

Woollen threads, after being woven into cloths, are subjected to the action of the fulling-mill. The object of this operation, which consists in beating the cloth in water, along with clay, is to free it from the oily matter with which it is mixed. It serves, however, the further purpose of felting the woollen substances, which contract under the operation.

The process of felting seems to depend upon the peculiar form of the filament. Though important and necessary in the case of woollen cloths, it is not so in the case of certain worsted fabrics, as flannel. It is not then desired that the fabric shall contract and cohere like cloth, but that it shall maintain a certain openness of texture; and the wool is more or less deprived of its felting property in the combing process.*

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* Mr Youatt, in his valuable Treatises on the Domestic Animals, contained in the Library of Useful Knowledge, has shown that wool is beautifully serrated, the serratures being produced by fine laminæ which rise from the filament in tiers of minute scales all round, somewhat resembling leaves. Mr Youatt has further very clearly shown, that the felting property of wool has a constant relation to the number and form of these laminæ. Thus, on comparing a fibre of the Merino wool of Saxony with that of the Southdown, he found that the former, which is far superior in fineness and felting properties to the latter, was $\frac{1}{840}$ of an inch in diameter,

The properties to be chiefly regarded in wool, then, are,—

1. The length of the pile, or filaments, which chiefly determines the peculiar species of manufacture to which it is appropriated: 2. The curling or crisping property: 3. The softness of the wool; with respect to which it is to be observed, that certain soils seem to communicate a greater or less degree of hardness to the filaments. The Saxon wools are noted for the property of softness; in a peculiar degree the Australian; and, amongst the native wools, the Zetland: 4. The pliability of the filament: 5. The regularity of the filaments and the absence of hairs: 6. The peculiar property termed felting.

Not only are fleeces thus different in the quality of their wool, but each fleece contains wool of different qualities with respect to fineness. It is the separating of these different sorts from one another that constitutes the process of *stapling*.

The stapler divides the wool of the fleece into nine, ten, or more different sorts, to each of which he gives appropriate names. The operative part of this process is one of nicety, and to which men are trained, as to the other mechanical arts, by a careful apprenticeship. In this country, the stapling or assorting of wool is sometimes performed by the manufacturer, but chiefly by persons termed wool-staplers, who purchase the raw material from the grower, and dispose of it, after it is assorted, to the manufacturer. The process of stapling is best carried on in the districts where the manufactures themselves are established, both because of the superior skill and experience which the workmen there possess, and because of the staplers being thus able to supply the manufacturer with that

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and contained 2720 serratures in the space of an inch; while the Southdown fibre was $\frac{1}{600}$ part of an inch in diameter, and contained only 2080 serratures in an inch; and farther, that the serratures of the Southdown wool were rounder and less acute than those of the Saxon. Numerous other examples equally conclusive are given of the relation existing between the number and form of the serratures, and the felting properties of the wool: and it is impossible to appreciate too highly the skilful observation and patient research, by which Mr Youatt has been enabled to establish those interesting facts.

precise kind of wool which the wants of a present market may requir^

IV. THE GOAT.

The species of the genus *Capra* enumerated by naturalists are,—

1. Capra ægragus—The Wild Goat.
2. Capra ibex—The Ibex.
3. Capra caucasica—The Caucasian Ibex.

Of these the *Capra ægragus* is believed to be the original of the many varieties of the domestic goat.

The Goat appears to form the connecting link between the sheep on the one hand, and the antelope tribes on the other. It is a lively creature, full of seeming caprice in its motions, and, although fitted for a life of liberty, yet easily domesticated, and becoming attached to its protectors. It is the natural inhabitant of a mountainous region; it delights to stand on the summits of rocks; it climbs the steepest ascents with ease, and, in springing from crag to crag, alights securely on the very verge of the precipice. Its feet, which are hollowed out, and have sharp edges, are nicely suited to this condition of life. It is not fond of feeding on the herbage of plains, but deserts them to browse on the heaths, shrubs, the wild thyme, and other plants of the mountains. It is not well adapted to a country of enclosures, because it browses upon the twigs of hedges, and escapes over the barriers intended to confine it.

It is in wild rocky countries, therefore, that the goat is chiefly reared; but often it is domesticated in the plains for the production of milk, for which the female goat is eminently adapted. She gives a great quantity of milk for so small a creature, and that rich, nourishing, and light. Like the cow, she yields it freely to the hand, and for a long time. She is readily taught to suckle the young of other animals, and becomes attached to her adopted offspring. She feeds readily in situations where the cow could not subsist, and this is a quality which gives a high value to the goat in many countries.

But in this island, the cultivation of the goat is limited and partial. It is chiefly confined to the mountainous parts of Wales, to parts of the remoter Highlands of Scotland, and to the little farms of the poorer peasants of Ireland, whose scanty possessions will not support a cow. In such a case as the last, the goat is a valuable creature, being easily and quickly reared to maturity, and feeding on herbs which other animals would reject.

The great objection to the rearing of the goat in this country is the want of demand for its flesh. Even the kid, whose flesh is known to be so delicate and nourishing, is in no estimation amongst us, and hence all the other properties of the goat are insufficient to render it an object of profitable production. But the goat, although it never can be so valuable here as in the dry and rocky countries of the south of Europe, does not deserve that entire neglect with which it is treated. It arrives early at maturity, and is very prolific, bearing two and sometimes three kids at a birth. It does not produce wool, but its hair may be shorn, and is of some little value; and its skin, and especially that of the kid, is in demand. It browses on heaths, and on plants rejected by other animals; and thus might, in certain situations, be fed in addition to other flocks, without injuring the herbage. The flesh of the old goat is indeed tough and strong-tasted, but it may be salted, and dried like bacon, as in Wales; and with respect to the flesh of the kid, this is not surpassed by that of the finest lamb. The goat, therefore, might certainly form an addition to the comforts of the cottagers of this and other parts of Europe, by supplying them with cheap food and milk.

V. THE HOG.

1. Species and Varieties.

Of the genus *Sus* the following species are peculiar to the Old Continent and its islands:—

1. Sus babyrussa—The Babyroussa, confined to the Indian Archipelago.
2. Sus larvatus—The African Boar, a very fierce and powerful creature, living in holes, and never yet domesticated.
3. Sus aper—The Wild Boar.

Of these species, the most widely distributed, and the most important, is the Wild Boar. He is found in Europe, Africa, Asia, and the islands of the Eastern seas. He is the parent stock of the domestic hog and its varieties.

The wild boar is a bold and powerful animal. He dwells for the most part, in moist and shady situations, and he feeds chiefly on plants and roots. In a state of nature his senses are acute, his ears very moveable, and his touch and smell so delicate, as to lead him to his food below ground, which he grubs up with his strong and flexible trunk, and this faculty he retains when in a state of slavery.

The female carries her young about four months, and she is rarely seen with the males but in the rutting season. She suckles her young for several months, and retains them near her for a considerable time afterwards, to defend them. When assailed, she protects her offspring with amazing courage, and the young reward her cares by a long attachment. She is sometimes seen to be followed by several families, forming a troop, formidable to their assailants, and destructive, by their ravages, to the cultivated fields. A remarkable contrast with the long cares of the female, is the solitary habit of the adult male, who will even, at their birth, destroy his own young,—a singular instinct of nature, given for some purpose that is unknown to us.

Although the domestic hog loses many of the characters of the wild race, he retains enough of them to prove his affinity; and all question upon the subject of his origin is removed by the change produced upon his progeny by domestication.

One of the most remarkable circumstances in the history of the domestic hog is, his general distribution over so many countries and distant islands, where no trace of any wild animal of the species exists in record or tradition. He was found extensively in the islands of the South Sea, when first visited by European voyagers, furnishing the principal animal food of the natives; and he exists in vast numbers in China, and the islands of the East. But what is remarkable, he is not indigenous in America, but was carried thither by the Spaniards; and he is not found amongst the quadrupeds of New Holland, though he has now multiplied greatly there. This universal diffusion he seems to owe to his extraordinary fecundity, his adaptation to every climate, and the facility with which he may be transported from one place to another.

The hog, though chiefly herbivorous in his natural state, may be fed equally well on animal food. It is this which renders him the most easily and cheaply reared of all the domestic quadrupeds.

Like the horse, the ox, and the sheep, the hog is affected in his character, size, and form by the physical state of the countries in which he is naturalized. But he is more the creature of artificial feeding than the sheep, the ox, or the horse; and hence his size is not so much dependent on the nature of the country in which he is reared. To the variations produced on him by external causes, we apply, as in the case of other animals, the term *breeds*.

The breeds of this country, as may be supposed, are very numerous. Those which may be referred to as illustrating the differences of size and character in the animals, are the following:—

1. The native hog of the Highlands of Scotland.
2. The Chinese hog.
3. The old English hog.
4. The Berkshire hog.
5. The Suffolk hog.

The native breed of the Highlands and Islands of Scotland consists of a small race, of a dun colour, with erect ears, rounded back, low shoulders, and with coarse bristles along the spine. They resemble the wild hog in their general form. They are usually left to search for their own food; and they will graze on the hills like sheep, and find their way to the shore on the ebbing of the tide, to feed on sea-weeds. They are far inferior to the improved varieties of the lower country; but they fatten when supplied with proper food more readily than their rough exterior would indicate.

The Chinese hog is of the widely extended Siamese breed of the East, a race which extends from the Continent to the islands of Sumatra, New Guinea, and others, and to all the islands of the South Seas. The true Siamese breed has the skin of a rich copper colour, but, like all the domesticated animals, the colour varies with conditions of climate, food, and culture. In China the colour is often white, and it is with the varieties derived from China, that we are the most familiar in this country.

The Chinese hog is for the most part less than the common swine of Europe, but it is distinguished by its peculiar aptitude to fatten. Its bones are small, its limbs short, its ears erect, its skin and bristles soft, and its general aspect delicate.

The introduction of this race has insensibly produced a great change in the character of all the breeds of this country. It has been made to cross the greater number of them. It has diminished the size, but removed the former coarseness of form, and increased the aptitude to fatten. The pure breed is little cultivated, and it is through the medium therefore of its crosses with the native stock, that its value is chiefly known. In this respect, the introduction of the Eastern hog into England has been singularly beneficial.

The old English hog may be held to be the type of the ancient swine of England. It is distinguished by its great size, its lank form, and its pendent ears. Remnants of this unimproved race are yet to be found, but for the most part they have given place to the more improved varieties. Although of defective form and slow feeders, the females are admirable nurses of their young: and when crossed by improved males, as the Berkshire, they produce a progeny possessing the aptitude to fatten of the male parent, with the large size of the dam.

The Berkshire was the earliest of the improved breeds of England, and is now the most generally diffused of all others. It has been undoubtedly formed by a mixture of the blood of the Eastern hog with the ancient swine of the country. The great improver of this breed was a Mr Astley of Oldstonehall. The modern Berkshire, however, is of less size than the older breed; but still the animals are usually of the larger class of swine. Their common colour is a reddish-brown, with dark spots; but many of the modern breed are nearly black, manifesting their nearer approach to the Siamese character; and sometimes they are black, broken with white, indicating the effects of the cross of the White Chinese. The Berkshire are justly regarded as one of the superior breeds of England, combining good size, with aptitude to fatten; and their flesh is fitted for pork or bacon.

In Yorkshire, Lincolnshire, and other eastern counties, there are breeds of a large size, of a white colour, and with pendent ears. They have been all more or less affected in their size and characters by crossing. A variety termed the Suffolk, is so named from the county of Suffolk, which has long produced great quantities of pork, chiefly for the supply of London. The Suffolk hogs have been crossed again and again with the Chinese, or descendants of Chinese crosses, so as to reduce the size for the purpose of suiting the taste of the consumers. The Essex breed has the same general character as the Suffolk; but generally with thinner skins. and bristles approaching more to hair.

The same system of crossing has been applied to all the former breeds of England, as the Rudgwick, the Cheshire, the Shropshire, so that the characters applied to these varieties by former breeders can scarcely be now traced in the progeny.

A breed has been lately received from the Mediterranean termed the Neapolitan. The animals are of small size, of a round and delicate form: their skins are of a coal black colour, and at the first introduction they are almost destitute of bristles; but when several times bred in England the bristles come. They have a great aptitude to fatten, and have on this account been received with favour, and they produce good crosses with the native stock.

In Scotland there are various mixed kinds. On the east coast the farmers prefer the small and kindly feeding hogs: on the west coast, where the dairy prevails, and the curing of bacon is established, they prefer the larger breeds. In Ireland vast quantities of hogs are reared, which used to be of a large size and coarse form. But within the space of a few years, a prodigious improvement has taken place in this part of the live-stock of Ireland. This has been effected chiefly by the introduction of improved males of the best English breeds, as the Berkshire and the Suffolk.

2. Form.

The same external characters indicate, in the hog, a disposition to fatten as in the other live-stock; and there is no other animal which can be made by cultivation to present so great a combination of these characters, or which can be so easily improved in its form, from the facility with which it receives the character of its parents, and from its rapid powers of increase. The chest should be deep and broad, the ribs largely arched, the neck short, and the head and limbs small; the bristles should be soft, approaching to hair, and the skin soft and elastic.

3. Rearing and Feeding.

The sow goes with young 112 days. She is fit to receive the male in the first year of her age, and the latter is able to propagate his species at the same early period, but he should be 12 months old before he is admitted to the female. The female produces from 5 to 10 or more at a birth, and she can easily be made to produce and rear two litters in the year; and she may even rear five in two years. She is ready to receive the male soon after the birth of her young; but the time should be chosen which allows her to produce her litter at the most convenient season. Thus, if she is to be made to litter twice in one year, the first should, if possible, be produced about the beginning of February, and the second about the beginning of August, so that the last litter may gain full strength before the arrival of cold weather.

When the sow is with young, she should not be wholly confined to a pen, but be suffered to walk at large in a yard or other convenient place, care being taken that, as the time of producing her young draws on, she shall not be crowded with others, lest she be injured by their feet.

The time when she is about to produce her litter will be known by her carrying straw in her mouth to make her bed. Before this, however, she should have been separated from her fellows and carefully littered. The straw should be short, and not in too great quantity, lest the pigs, nestling beneath it unperceived by the dam, be crushed by her when she lies down.

While nursing, she should be well fed, and the pigs accustomed to feed from a trough on milk, whey, or any liquid food, mixed with a little meal or bran. In 30 days the males may be castrated, and a like operation, though not absolutely necessary, may be performed upon the females at the same time.

During the period of nursing, the dam and her young should be lodged dry and warm. They should be fed three times in the day with whey, milk, and a little water slightly warm, mixed with bran, meal, or any farinaceous substance, and when the pigs are in the course of feeding from the troughs, the mother may be allowed to go at large for an hour or two.

In six weeks, if they are well fed, the pigs may be weaned, but should they not have been well fed, eight weeks will be required. When weaned, they are to be fed three times a-day with wheat-bran, barley-dust, or any farinaceous food, mixed with water warmed to the temperature of the mother's milk, and with whey, or other refuse of the dairy or the kitchen. In a few weeks they will begin to eat potatoes, turnips, and all other food.

The young pigs are sometimes disposed of when sucking the dam. In other cases they are sold when weaned to persons who design to feed them; and in other cases they are fattened by the breeder himself.

When they are fattened by the breeder, two modes of feeding may be adopted. They may either be suffered to go at large, or they may be kept in pens and houses. By the first of these methods, after being weaned and fed for a period till they are able to shift for themselves, they are turned abroad to pick up what they can in the straw-yards, a little green food, as tares or clover during summer, and turnips or potatoes during winter, being supplied to them. They do not, under this management, receive any more expensive feeding until they are put up finally to be fattened, when they are confined for a few weeks, and fed on farinaceous and other food. The pigs intended for this species of management should be the best of the smaller varieties; and they may be killed for domestic use, or disposed of when of 7 or 8 stones weight. All the accommodation required under this system of management, is a few pens with sheds; first, for the breeding sows when nursing their young; and second, for the pigs which are in the course of being fattened.

In all cases upon a farm, a certain number of pigs may be kept at large in this manner for picking up the waste of the farm-yards. But the regular course of management, and that to be adopted where the feeding of the animals is carried on on the larger scale, is to have separate feeding houses for the pigs, in which a greater or lesser number can be kept.

The same general principle of feeding applies to the hog as to the other domestic animals. The breeding stock is to be kept in good order, but not over-fed; the feeding stock is to receive a full allowance of good food from the period of weaning until it is fat.

The food of the pigs is every kind of animal refuse, as that of the dairy and kitchen. Roots of any kind, raw and boiled, will be eaten by them; but it is better that this species of food be boiled or steamed. Bran, steamed or boiled, is likewise a nourishing food for pigs; beans and pease bruised may be also given to them; and brewers' grain and wash furnish one of the best kinds of food that can be supplied. Hay or dried fodder is not relished by this class of animals; they require food of a moist and succulent kind, and, therefore, though they dislike dried forage, they will not refuse hay, and even straw, if chopped and boiled. They feed on green food of all kinds; and hence clover, lucerne, and tares may be employed in feeding them in summer, though to fatten them finally some farinaceous or other nourishing food will be required. They will also graze like sheep or oxen, but grass consumed in this manner is not the natural food of the animal, which consists of roots rather than of herbage. The feeding of pigs on herbage, is merely to carry them on for a time till more fattening food can be procured for them. When fed on herbage, a ring must be passed through the cartilage of the nose, to prevent their following their natural instinct of ploughing up the ground, but the same purpose may be more effectually served, by dividing the tendons by which they are enabled to move the snout. Acorns and beech-mast are a favourite food of the hog, but these are rarely furnished in sufficient quantity for the purpose of feeding, though in cases where there is access to woods producing these fruits, hogs may be turned into forests with advantage. All kinds of spoiled or waste fruits may be given to them; and in the cider districts accordingly, the refuse of the cider press is employed for feeding them. In short, the animal is omnivorous, and there is not any species of animal or vegetable food which may not be given; and in the case of no other of the larger animals, accordingly, is the process of feeding so simple.

Pigs ought to be fed three times in the day, and the troughs in which the food is placed should be emptied before a fresh supply is given, and kept perfectly clean. It is well to vary their food, to mix it with water or other liquid, and not to overload them by too much at a time. It is a great error to leave these animals in a state of filth and neglect. The hog is not a filthy animal by choice; he delights in a clean bed; he will wallow indeed in the mire, like the elephant, the rhinoceros, and other pachydermatous or thick-skinned animals to which he belongs; but this is not because he prefers filth, but because he loves coolness and moisture.

There are two purposes for which pigs may be fattened. The one is to yield pork, which may be used either fresh, salted, or pickled, and the other is to produce bacon, which is prepared by salting and drying the flesh. When fed for pork, which is the most convenient system in the practice of the farm, the pigs may be reared to the age of 6 or 8 months; when intended for bacon, they must be reared to a greater age and size, as 10 or 12 months. When the object is pork, the smaller class of early-feeding pigs is to be preferred; when bacon is desired, the larger class should be cultivated.

In the case of feeding for pork alone, it has been computed that, upon a regular farm, with a supply of tares and clovers to the animals in summer, and of potatoes and turnips in winter, and with no other feeding than the refuse of the barn, milkhouse, and kitchen, one pig may be fattened in the year for every 6 acres of land under corn-crop. Thus, supposing there are to be 240 acres in corn-crop, the quantity of pigs fed annually upon the farm might be 40. To fatten this stock, in addition to what they can pick up in the straw-yards, about an acre and a quarter of clover, and an equal quantity of potatoes during winter, will be sufficient. To keep up the number, 3 breeding sows will be required, of which two should be sold in each year, their place being supplied by an equal number of younger ones reared upon the farm. The surplus beyond the quantity of 40, which it is proposed to feed, may be disposed of when weaned. This is a method of management practicable upon ordinary farms, without any interference whatever with the food and attention required for the larger stock.*

Another method of management may be adopted. This is to take only one litter of pigs from each sow, to sell the pigs as soon as they are weaned, and immediately afterwards to feed the sows. This will be a very profitable species of management, provided there is a sufficient demand in the district for so many pigs when weaned.

Mr Henderson, in his Treatise on Swine, recommends this system. He calculates that 1 sow for every 7½ acres upon a farm, may be reared and fattened in this manner. He proposes that the breeder shall purchase, in the first place, 20 sow pigs and 1 boar pig, which had been born the beginning of June. In the following June all the females will have had pigs. These they are to suckle for about two months. The pigs are then to be sold just when weaned, except 21, namely, 20 sow pigs and 1 boar pig; these being selected from those which are of the handsomest shape, so that the subsequent stock may be kept good and uniform. The farmer will now be in a situation to go on without further outlay of money for stock. In a month after the pigs are weaned and sold, the sows themselves are to be put up to fatten. This will be about the beginning of September. The male must be then admitted to them, so as to render them quiet and apt to feed, and in two months they will be fat and of large size.

Pigs, it has been said, may either be used for pork, fresh, salted, or pickled, when they will be ready in 6 or 8 months, or for bacon, when they will be ready in 10 or 12 months.

In the case of pickling pork, the carcass is to be cut in pieces, and may be packed in kits containing from 1 to 2 cwt. Salt is then dissolved in water, so as to form a strong brine, and this being boiled, is cooled again and poured upon the pork so as to cover it. This simple process prepares the pork for market, so that the preparation of it may be carried on with the greatest facility upon the premises of the farmer.

When the animals are designed for bacon, the operation is performed by cutting the body so as to separate the hams or legs from the flitches or sides, the body for this purpose being cut first along the back-bone and then transversely. The hams and flitches are then laid on boards, sprinkled with saltpetre, and covered with salt. They are then separately salted again, and at length put in a chimney or smoke-house to dry. The proper period for curing bacon is in the cold months, namely, from the middle of September to the middle of April.

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* Brown on Rural Affairs.

Private families in the country may supply themselves with fresh or pickled pork by very easy means :—Let a good sow be procured of the early feeding kinds, as the Berkshire or Chinese cross. This sow will produce from 15 to 20 pigs every year, and these pigs may be rendered sufficiently fat for domestic use when 4 or 5 months old. It is unnecessary to keep a male if one amongst the neighbouring farmers of the same breed is to be found. Let a small house be formed sufficient to hold 2 pigs at once, and for convenience as near the kitchen as possible. Let a pig be killed every three weeks, the oldest being taken first, and his place being supplied by another. With attention the animal will be ready in six weeks after being put up. In this manner a family may be supplied with fresh and pickled pork plentifully throughout the whole year, and at a very small expense. During the hot months the pork may be pickled in a cold cellar, in a manner sufficient for household use ; or a portion, if wished, may be converted into small hams like those of Westphalia.*

When we regard the number of mankind fed upon the flesh of this animal, it must be seen that he occupies an important place in the domestic economy of countries. His flesh is perfectly nutritive, and from its ready reception of salt, it is better fitted for preservation than that of any other animal. It is thus eminently adapted for sea-voyages, for which purpose it is largely used. It forms a great part of the animal food of the labouring classes of Europe. The hog is truly the poor man's stock, since it may be raised by the cottager as well as by the breeder on the larger scale. There is no animal which, in proportion to the food consumed, yields so great a quantity of muscle and fat. His flesh indeed may not be so profitable as that of the sheep and the ox, but this arises from the facility of production, and the consequent tendency of th to be overstocked.

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* Henderson on Swine.

To the settler in a new country, the hog is the most valuable of all the larger domestic animals used as food. He is beyond every other quickly multiplied, reared, and brought to the required maturity. The clearers of land in the American forests could hardly subsist during their first year of labour and danger without this creature.

And in our own country it is a great error for a farmer, however extended his concerns may be, to disregard this branch of farm-stock: it is to him a source of household economy and comfort. He can raise the most delicate pork for use at all times, and with the greatest facility, and will always derive a sufficient profit by the sale of the remainder, to repay him for his feeding, and induce him to give attention to this branch of economy.

VI. THE RABBIT.

Of the genus *Lepus*, the species to which the term Rabbit is usually applied are:—

1. Lepus cuniculus—The Common Rabbit.
2. Lepus tolai—The Siberian Rabbit.
3. Lepus americanus—The American Rabbit.

That which forms the subject of cultivation in the north of Europe is the Common Rabbit.

The rabbit is a subject of considerable attention in some countries. It is reared partly for its fur, which is employed chiefly in the manufacture of hats, and partly for its flesh. It is a wonderfully prolific creature; it will breed seven times in the year, and produces from 5 to 10 young at a time. Were its numbers not thinned by a multitude of beasts of prey, as the fox, the weasel, the polecat, and the hawk, it would soon overspread the face of the country ; but these animals to which it serves for food, retain it within its due limits ; and as if for a further security against its excessive multiplication, the male parent is endowed with the propensity to destroy his own offspring.

At the age of six months, the rabbit is able to propagate. The female goes with young 30 or 31 days. Previous to bringing forth her young, she makes a bed of down, which she pulls from her own fur. She tends and suckles her young with surprising solicitude, and never leaves them except for necessary food. She conceals them from the male, lest, obeying his natural instinct, he should destroy them.

The flesh of the rabbit is, in some countries, much esteemed. In England it is little valued, although still the consumption of the great towns is considerable.

The rabbits with us are of two kinds : the wild rabbit, which is reared in warrens, in a state of comparative liberty : and the tame rabbit, which is reared and fed in yards and houses.

The fitting soil for the warren is sand, and the best situation for it, sandy downs, which are of little value for tillage. Warrens are of every variety and extent. When not naturally stocked, they may be stocked at the rate of 3 couples to the acre, there being 1 male for every 7 or more females. The warren should be enclosed by a wall, so as to prevent the depredations of the rabbits on the neighbouring fields. The management of the warren itself is simple. It is to be protected from dogs and beasts of prey, while mice, rats, and other vermin are to be destroyed. The rabbits are themselves caught in traps and nets, and sent to market in such quantities as they are produced. They are generally disposed of by the dozen or hundred, and their fur is of the most value from October to January.

It is generally found that the rabbit-warren in this country is a very unproductive species of property. At the present price of the animals, there is scarce any inducement to preserve existing warrens, and none to form new ones.

If the rabbit, then, is to be cultivated in this country for profit, he must be reared in the house or yard, and then the variety to be selected is the tame or domestic rabbit.

The domestic rabbit is larger than the wild, and is greatly diversified in size and colour. His flesh is more white and delicate than that of the wild rabbit, but generally less valued, because possessing less of the game flavour.

The variety chosen for breeding should be of the larger kinds. Those termed the French and Turkish rabbits are much esteemed. The rabbit selected for breeding, we are informed by the breeders of them, should be wide in the loin and short-legged. It thus appears that the external characters which indicate a disposition to fatten in the other domestic animals, indicate the same property in the rabbit.

In the management of the rabbit, the utmost attention must be paid to ventilation, cleanliness, and food. The animals are most conveniently kept in boxes or compartments termed hutches, one above the other round the room. Each hutch intended for the does should have two divisions, one for feeding and the other for sleeping. Those are single which are intended for the use of the weaned rabbits, or for the bucks, which are always removed from the female after copulation.

There should be little troughs in the hutches for the food, which consists of corn, hay, roots, and green plants, or any farinaceous substance. Boiled potatoes are an excellent food for the rabbit, as for every kind of herbivorous animal.

The female, when the time of parturition approaches, makes her nest, for which hay is to be furnished her. She bites it with her teeth into the requisite size. She generally produces from 5 to 10 young. At the end of six weeks the male is again admitted to her, and the young ones weaned, or she is allowed to suckle them for two weeks more.

They are either sold from the teat, when they are extremely delicate, or they are kept on for a certain period and fattened.

Good and nourishing food is to be supplied to them, and three months' feeding is generally considered necessary to feed them properly.

From the statement given, it will appear that the rearing and feeding of the domestic rabbit is extremely easy, and that there is no class of animals so prolific. The cultivation of the animal, however, can only be carried on successfully where there is a demand for the produce. But if it were the habit of the people, the rearing of the domestic rabbit by various classes in this country would furnish, at little expense, a grateful change of wholesome and nourishing food.

VII. DOMESTIC FOWLS.

The domestic fowls reared in Europe for food are comprehended under two divisions:

1. *Gallinaceæ,* the Cock kind, comprehending the Common Cock, the Turkey, the Guinea-fowl, the Peacock, and the Pigeon.
2. *Palmipedes,* the Web-footed kinds, comprehending the Duck, the Goose, and the Swan.

1. The first in importance of the gallinaceous fowls, is *Phasianus gallus,* the Domestic Cock. To what region we owe this creature is unknown. He is found from the equator to the limits of the temperate regions. In Asia and its islands he is very abundant, and sometimes of large size and great beauty. The large Cock of the forests of the East, termed the Jungle-Cock, is one of the species or varieties in its wild state, and i supposed by some naturalists to be the origin of the domesti kinds.

The male of the domestic species, were we not daily fami liarized to the sight of him, would appear to be a very gracefu bird. His gait is erect, his eyes are sparkling, he is armed wit spurs for his defence, and he is endowed with a courage whic often causes him to die rather than yield to an enemy.

The female is remarkable beyond all other birds for he fecundity; she continues to lay eggs throughout a great par of the year; the period in which she ceases to do so, or does so very sparingly, is that of moulting, which generally lasts from one to three months. After having laid a certain number of eggs, the desire of incubation takes place. This is indicated by strong emotions, and a peculiar cry; and she will sit on any eggs that may be presented to her. Many expedients, some of them very cruel, are practised to check the instinctive passion, so as to cause the animal to lay eggs rather than to hatch.

It is remarkable that while some of the females show this desire in the strongest manner, others scarcely manifest it, or, showing it, it quickly leaves them. Hence, while some are engaged in producing eggs, others are ready to serve the office of mother, and on this account there is no kind of the domestic fowls that can be propagated so quickly, and in such numbers.

The period of hatching is 21 days. The female during this time manifests increasing watchfulness. She will scarcely be induced to forsake her charge, even by the most pressing claims for food, and hence food should be placed within her reach. The number of eggs which one mother is allowed to hatch, is generally from 10 to 15.

The young is gradually nourished within the shell. It lies without motion; its position is remarkable; its breast is towards one end of the egg, which is formed large for that purpose; its legs are bent forward to the breast; its head is couched beneath one of its wings, and its beak rises from between the wing and the back.

When the time of its maturity is at length arrived, the desire of life and motion awakes. The little creature employs its beak, thus singularly placed, for the purpose of breaking its covering. It is heard to tap the shell; the emotions of the mother increase as she listens to the attempt of the young to come forth. The beating of the beak is generally continued for 2 hours, sometimes for 6 hours, and sometimes for a longer time. At length the shell is broken, and the young is enabled to come forth from its marvellous mansion.

The anxious mother has no milk to give to her young when they come into day; but nature has provided for all their wants. The mother teaches them to find their food almost as soon as born, and their little bills are sufficiently hardened at their birth to pick it from the ground.

The change of nature in the parent is very remarkable. From the most timid of creatures, she now becomes fierce and courageous; she will attack the largest animal in defence of her young; she watches them with surprising solicitude; she shelters them under her wings, and leads them where food is to be found. After a time her cares cease; she gradually recovers her natural timidity; she finally resumes all her habits, and leaves her long-cherished offspring as if never to know them more.

The varieties of the common fowl in this country are very numerous, and are distinguished from one another by their size, colour, and fecundity.

The Game-fowl is a very singular creature on account of its habits. Its size is less than that of the common kind; but the symmetry of its limbs is greater, and the beauty of its plumage is remarkable when not mutilated for the barbarous sport for which it is destined. Its flesh is white, and esteemed beyond that of all the common kinds for its delicacy and flavour; but the singular pugnacity of its disposition, which shows itself at the earliest period of life, deters all breeders from rearing it except for the purpose of gaming. Whole broods, scarce feathered, become blind from continued fighting; and a very small number, accordingly, of any brood can be reared. Neither can they be employed to cross the common fowls, because they never fail to convey the same pugnacity of disposition to the offspring.

This singular temperament of the animal has been known, and turned to a barbarous purpose, from the earliest times; but whatever may be the design of this peculiar nature of the animal, it cannot be imagined that it was intended to minister to the cupidity and evil passions of gamblers in a cockpit. The cruel sport, therefore, to which the nature of the animal gives rise, should be proscribed by public feeling.

The Dorking fowls, so named from a town in Surrey, in the neighbourhood of which they are raised, are the largest and finest of our domestic breeds. Their colour is wholly white; their body is capacious, and they are prolific layers of eggs. They are distinguished by having five claws on each foot.

Equal to the Dorking in estimation are the Poland fowls. Their colour is black, their heads flat, and surmounted with a crown of feathers. They are a very useful variety, prolific of eggs, but less inclined to sit than those of any other breed.

The Bantam is a little Indian breed, very delicate to eat, but, from the smallness of its size, not of any economical importance.

The Chitagong or Malay fowl, is the largest breed that has been yet brought to this country; but the flesh is regarded as inferior to that of the Dorking and Poland.

When it is wished to form a breed of fowls, the breeding should be from a young stock. Hens are at their prime at 3 years old, and decline after the age of five. The best period to commence breeding is in spring.

The methods of feeding fowls are various. The most common, is to suffer them to range about the homestead, in which case they are termed barn-door fowls.

Whether the fowls are suffered to go at large, or are confined, there should be a poultry-yard. where they may be regularly fed, and this should be on dry ground, and well gravelled. There should be water in the yard, and it should be sheltered from the north and east. There may be put in the yard a quantity of dried sand, that the animals may indulge the propensity so natural to them of rolling or basking.

There must likewise be a house for the animals to roost and hatch. In this should be placed perches, to which they may ascend by steps without flying, and these perches should be placed on a range or level, and not one above the other; and round the interior should be placed boxes for the fowls that are hatching. When there is only one house, the boxes for the web-footed fowls should be below, and those for the hens above, protected by little boards in front, and with steps by which the fowls may ascend.

The common fowls of a farm may usually be suffered to go at large, care, however, being taken that they shall be regularly fed in the poultry-yard morning and evening. But when fowls are reared in large numbers for sale, feeding-houses must be employed, in which are troughs with water and food placed all around, so that the animals may feed constantly without interruption. Poulterers know how to feed fowls with great expedition; and their method seems to be to give every kind of nourishing food. It is indeed under every circumstance the rule of experienced feeders, to give the animals a full allowance of food from their birth to their maturity. The same rule applies to them in this respect, as to other animals reared for food.

Wheat, barley, and oats, are all employed for the feeding of poultry. Poultry, indeed, will feed on any kind of farinaceous substance, and the better the quality of the food, the more will the animals profit by it. And not only will they feed on farinaceous food, but on animal substances, as grease, suet, and milk; sugar and treacle, too, are consumed by them; and it is by this kind of mixtures that poultry-feeders are enabled to produce so rapid a degree of fatness.

The cramming of poultry consists not only in feeding with these substances, but in forcing them down the throats of the animals. The ingredients employed are made into little balls, and the fowls are kept in coops, and crammed night and morning. In this way they are fattened in a very short time.

Eggs are an extensive product of common poultry. They form an object of vast consumption, and are produced in numbers not to be computed. Mr Lawrence, in his work on Poultry, states that from 5 Poland hens he obtained, in 11 months, 503 eggs, weighing, at the average of 1 oz. 5 drams each, 50½ lb.* From this will appear the great production of animal food from this source. To preserve eggs, the pores of the shell should be rendered impervious to the air. Unctuous substances of different kinds are employed for this purpose, as suet melted, oil, and the like. Other substances are employed, as water saturated with lime and salt.

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* Practical Treatise on Breeding, Rearing, and Fattening Domestic Poultry, &c., by Mr Lawrence, under the assumed name of Moubray.

2. The Turkey, *Meleagris gallo-pavo*, is a native of America, He was found by the Spaniards, both in a wild and domesticated state: he was named the Indian Cock, and sometimes the Peacock of the Indies; he seems to have been introduced into this island soon after the discovery of America.

In his wild state, the colour of the turkey is black, variegated with bronze and glossy green; and his quills towards the ends are tipped with white. By domestication he acquires that variety of colours which we see him to possess. In his native woods, the turkey is found in large flocks; he roosts upon the highest trees, and becomes an easy prey to the hunter; he retires before the progress of the settler, taking refuge in the boundless forests of the interior.

The turkey is an important addition to the domestic fowls of Europe. There is but one species of the domesticated turkey, but great varieties, distinguished chiefly by their size and colour.

The turkey is more tender, and difficult to rear, than the common domestic fowls. The hen lays a considerable number of eggs in spring; the period of her incubation is 30 days; and from 10 to 15 eggs are usually assigned to one female. She will sit upon her eggs frequently without the desire to leave them, and hence the propriety of supplying her with water and food while sitting. Her cry at the period of maternal solicitude is plaintive and expressive, but she treats her young with less seeming care than might have been looked for. She travels with them very fast to great distances, and often leaves them straggling behind her; hence it is usual to confine her to a coop till the young have acquired strength to follow her. And frequently even, on account of her wandering habits, her eggs are given to be hatched by a common hen. She is wonderfully vigilant when birds of prey appear; and by a peculiar cry, or crouch themselves upon the ground.

As soon as the young are hatched they must be withdrawn from the nest, and kept warm. The hen and brood must then be housed for some time, after which she must be cooped during the day in the open air, till the young acquire strength to follow her. During this period the young are fed on farinaceous food, kneaded with water, and mixed with cresses, nettles, or other green herbs, cut small. Though they are tender at first, yet when half-grown, and well feathered, they become hardy, and will range abroad, providing themselves with insects and other food; but care must be taken that they be well fed when let out in the morning, and when they return in the evening. It is to be observed, that if a large wood be near, the creatures, with the instinct of their race, will stray towards it, without any seeming wish to return.

When they are put up for final fattening, sodden barley, or the meal of oats, barley and wheat, are their appropriate food. A common practice is, after they have been allowed to glean in the stubble fields in autumn, to put them up for fattening. A good weight for a turkey is 15 lb.; but they are sometimes fed to 20 and even 30 lb. The process of cramming is also adopted with the turkey, and thus it is compelled to become fat in the shortest time. The eggs of the turkey are regarded as delicate by those who are used to them, but they are not much an article of consumption.

3. The Pintado or Guinea-fowl, *Numida Meleagris*, is a native of Africa, where it is found in vast flocks; but it is now diffused over every part of Europe, the West-India Islands, and a great part of America. The pintado is a restless, noisy bird; the female lays numerous eggs, which are smaller than those of the common hen, but esteemed much more delicate; like other gallinaceous birds, she is apt to secrete her eggs until she has produced her brood.

The pintado is an agreeable variety in the poultry yards of Europe, liked by some for its flesh, and by all for the delicacy of its eggs; but it is of little economical importance. The

chicks are very tender,
in spring. They are generally hatched by the common hen, who either covers a larger number of them, or is found to be a more careful nurse than the pintado herself.

4. The Peacock, *Pavo cristatus*, need scarcely be mentioned as a bird of economical use. Pea-hens and pea-chicks, indeed, are occasionally used for food, but this splendid creature is, and ought to be, regarded solely as an object of beauty. The advantages to be derived from rearing it for food are not to be thought of.

5. The Common Pigeon, *Columba livia*, is of a race of birds multiplied throughout the warmer and temperate regions; but it is in the warmer regions that they attain to their greatest size and beauty of plumage. They have been in all ages the favourites of mankind, to which their innocence and beauty seem to give them a peculiar claim. But if it be as farmers that we are to regard the pigeon, the beautiful favourite unfortunately cannot attract much of our regard. Nothing beyond the gratification of luxury can be derived from the cultivation of the domestic pigeon for food. In vain has it been asserted that pigeons do not feed upon green corn, cannot dig into the earth with their bills, do little harm to the cultivated crops, and consume only the seeds of injurious plants. The experience of farmers shows that the damage done by these creatures to our various crops of wheat, pease, and beans, is very great; and certainly the waste is in no degree compensated for by the quantity which the animals afford of human food.

Yet, as pigeons are in demand as objects of consumption, and as they afford a luxury and convenience to those who live in the country, the subject of their management is, like every branch of husbandry, deserving of attention. If pigeon-houses are to exist at all, those who possess them should know how they are to be best managed, so that the largest return may be derived from them. Though there is scarce any branch of the management of the domestic fowls more misunderstood, yet the essential rule of management is simple. Its principle consists in regular feeding, in giving sufficient space to the birds, and in paying a strict attention to cleanliness.

The next in order of the domestic fowls are the Web-footed. These birds, when domesticated, become enlarged in their form, and wholly the creatures of their new condition; though they still remain partial to an aquatic situation, swimming with facility, and feeding on fish, insects, and the leaves and grains of aquatic plants. They are hardy, easily propagated and fed, and afford a rich and savoury food.

1. The Wild Duck or Mallard, *Anas boschas*, is the original of the common domestic species. It is widely diffused over the world, inhabiting Europe, Asia, and America. These birds live in the marshes, lakes, and rivers of the North in incredible multitudes. In autumn, they migrate southwards in numerous bodies, the greater part returning in spring to their former haunts, though large flocks and scattered pairs remain and breed in the morasses and rivers of lower latitudes.

The wild duck in its natural state is a wonderfully shy and cautious creature. It breeds once in the year, the pairing time commencing about the end of February, and each couple living apart amongst the reeds of lakes, rivers, and marshes, where they breed. Nothing can be more tender than the care of their offspring by these birds. The nest is formed on the ground, generally in a tuft of reeds or rushes, bent into form, and lined with the down of the parents. The incubation lasts 30 days; when the female quits her charge for food, she covers up the eggs, the male in the mean time keeping watch near the nest; and when she returns, she approaches cautiously, winding that she may avoid discovery. The young burst their shells nearly at one time, and in a few hours the parents conduct them to the stream, where they at once begin to swim, and feed on herbs and insects; and at night they are gathered together under the wings of the dam. In three months they can fly; and in three months more their growth and plumage are complete.

The domestic duck adapts his habits to his new condition.

He no longer retires with one female to pair, and tend his brood, but becomes polygamous; and he loses the caution and sense of danger which distinguish him in his wild state. Still, as in the wild state, by means of his nicely-formed bill, he finds in marshes and elsewhere the food that is suited to him. He feeds alike upon animal and vegetable substances; on the spawn of fish, and the larvæ of insects; upon grass, the seeds of aquatic plants, and even sea-weeds. These birds may be said to be omnivorous; and this it is which, with their hardy qualities, renders them so easy of culture.

The duck begins to lay her eggs in February, and, obeying her natural instinct, she will, unless confined, lay them abroad, and conceal them. During the period of hatching, she requires no other care but to be kept undisturbed. When she wants food, she will go in search of it, covering up her eggs as in the wild state. When the young are hatched, they should be allowed to remain in the nest so long as the dam chooses; after which she may be put into a coop in the open air during the day for a short time. She should then have a full allowance of good food and water, while the young should likewise have a flat dish put down to them with water frequently renewed, with a proper supply of meal or other farinaceous food.

A common hen is frequently substituted for the natural parent to hatch the eggs of the duck. But wherever there are any pools of water, the proper nurse is the duck herself; she conducts her young to their natural element, and brings them from it when it is time, while, when a hen is the nurse, they disregard her signals on the bank, and do not themselves know when to return.

The feeding of these fowls is easy. In certain situations, they are allowed access to their natural haunts, the marshes and the bogs, where they feed; and when they are to be ultimately fattened, they are fed for a short time on farinaceous food.

As in the case of other fowls, there are also breeds of the common duck more or less valued; and there are some singular varieties, as the hook-billed duck, reared in aviaries and poultry-yards.

The Mallard is the original of the ducks usually reared for economical purposes. Other species, too, are sometimes domesticated. One of these is the Chinese duck, *Anas galericulata*. A large species is the Muscovy duck, or, as he ought rather to be called, the Musk duck, *Anas moschata*, a native of Paraguay, and the neighbouring provinces. He there perches on trees by the sides of rivers and marshes, and breeds several times in the year: he is very shy in his wild state, but readily submits to domestication: he is larger than the common species, very prolific, and easily fattened.

2. The Wild Goose, *Anas anser*, is another of this valuable family, widely extended over the world, and susceptible of entire subjection to the will of man.

Like the wild duck, this fine animal quits the swamps of the vast wildernesses of the North on the approach of winter, and migrates far to the South. From 50 to 100 individuals are often in flight together, at a vast height, sometimes beyond the reach of vision, and only recognised by their shrill voices. All have witnessed the surprising regularity of their flight; the leaders forming the apex of an angle, and cleaving the air, as it were, for those that follow. They pursue their lofty flights from vast distances, and when they alight for food or rest, they station sentinels, to guard them from surprise.

Part of them remain to breed in the lakes, rivers, and fens of lower latitudes, but the greater number of them return to the boundless regions of marsh and forest whence they had taken their flight, and where they can rear their young in security.

The domestic race of this species generally loses the desire of escaping, although a few instances occur of the tame joining the wild race. The tame variety is reared in every civilized country. Its habits render it an easily cultivated animal, and it is an object of great economical importance in the districts of fens and marshes, which are the most suited to the rearing of it.

The period of incubation is from 27 to 30 days, and the female covers conveniently from 11 to 15 eggs. She manifests the period by carrying straw in her mouth, and then a nest should be prepared for her in a secure situation. During the time of hatching, the male stands a watchful sentinel, and will fiercely attack the largest animals that approach the nest.

After the young are brought from the nest, the dam may be penned with them on a spot of dry grass, while farinaceous food, water, and any wholesome green herbs, must be supplied. After a short time, the dam and her brood should be allowed to forage for themselves in the fields and marshes. They are perfectly herbivorous, and will graze like sheep. Those who are favourably situated with respect to the means of rearing these fowls, seldom give them any more attention, than to drive the broods, with the dams, to the contiguous fens or marshes where they feed.

In situations less favourable, more attention must be paid to the feeding of them. They must be well supplied with food like other fowls, but it constitutes the particular facility of rearing these animals, that not only farinaceous substances, but every kind of edible herbs, as turnips, potatoes, the refuse of the garden, and the like, may be given to them. They may be soiled, too, on clover and tares; and when being fattened, steamed potatoes, meal mixed with milk, and the like, may be given to them.

The young are either disposed of at a month or 6 weeks old, when they are termed green-geese, or they are retained till after harvest, and fed upon the stubbles, when they are termed stubble-geese. If they shall not be sufficiently fattened on the stubbles, they must be put up to feed, all that is necessary in this case being, to give them plenty of water and constant food, and to litter them carefully with straw.

Besides the produce in flesh, there are derived from this animal down and feathers, both those of the wings, which are made into writing-quills, and those of the body, which are applied to different uses. This has given rise to the dreadful barbarity of plucking the animals, which is sometimes done five times in the year.

The only really important species reared in this country is that which has been described; but peculiar varieties or breeds are distinguished and valued according to their size and qualities. Of these, the most esteemed are the Spanish and the Embden geese. These varieties are both white in their colour, and of good size.

Other species of the goose have been introduced into our pleasure-grounds or poultry-yards, as curious or ornamental. The Egyptian goose, or barnacle, *Anas ægyptiaca*, is remarkable for the veneration paid to it by the ancient Egyptians. The Chinese goose is a pretty animal, more graceful, and somewhat smaller than the common kinds. The Canadian goose, *Anas canadensis*, too, has been domesticated in different parts of Europe, and becomes as familiar as the common kind.

3. The Domestic Swan, *Anas olor*, has in this country ceased to be regarded as food, and is now preserved solely for the beauty and majesty of his form, with respect to which he is the noblest of all the water-fowls. He feeds like the goose, but is more aquatic in his habits. He is gentle and familiar to his keepers, eating his food from the hand; but while engaged in the rearing of his brood, he is fierce and dangerous to be approached. He is a bird of great courage, but is never the assailant of others.

XI. GENERAL ECONOMY OF THE FARM.

I. BUILDINGS OF THE FARM.

The buildings of the farm are to enable the farmer to thrash and prepare the produce of the ground for use; to preserve his corn and other seeds; to prepare and collect manures; to keep his working cattle; and to divide, shelter, and feed his other live-stock.

For the economy of labour, the buildings of the farm should be as near as possible to the centre of the cultivated grounds; for most of the produce of the farm being, in the first place, conveyed to the farm-buildings, and the manure carried from them to the fields, it is important that the parts of the farm shall not be so distant from the buildings that time shall be wasted by the men and working cattle in travelling.

But, although a central situation of the farm-buildings is as much as possible to be aimed at, it is often necessary or expedient to sacrifice this convenience in order to secure others.

A primary object is the obtaining a sufficient command of water for domestic purposes, and the use of the live-stock. This cannot be obtained in every situation, and convenience of position, therefore, in the buildings, must often be sacrificed, in order to obtain the necessary supplies of water. Sometimes water can be procured in sufficient quantity by sinking wells; but it is always better that it be obtained by a constant flow or current, that the stock of the farm may be supplied at all times without the labour of pumping. Where a brook or rivulet of any kind does not exist, water can be frequently conveyed to the buildings from a distance in drains or pipes. And when farm-buildings are to be erected, a preliminary examination of the means of procuring this necessary material must never be omitted. Besides the supply of water for domestic purposes, and the use of the live-stock, it is often important to have it in sufficient quantity for a water-power. However beneficial, then, it be to place the farm-buildings in a centrical situation, this object must be often sacrificed in order to secure other advantages.

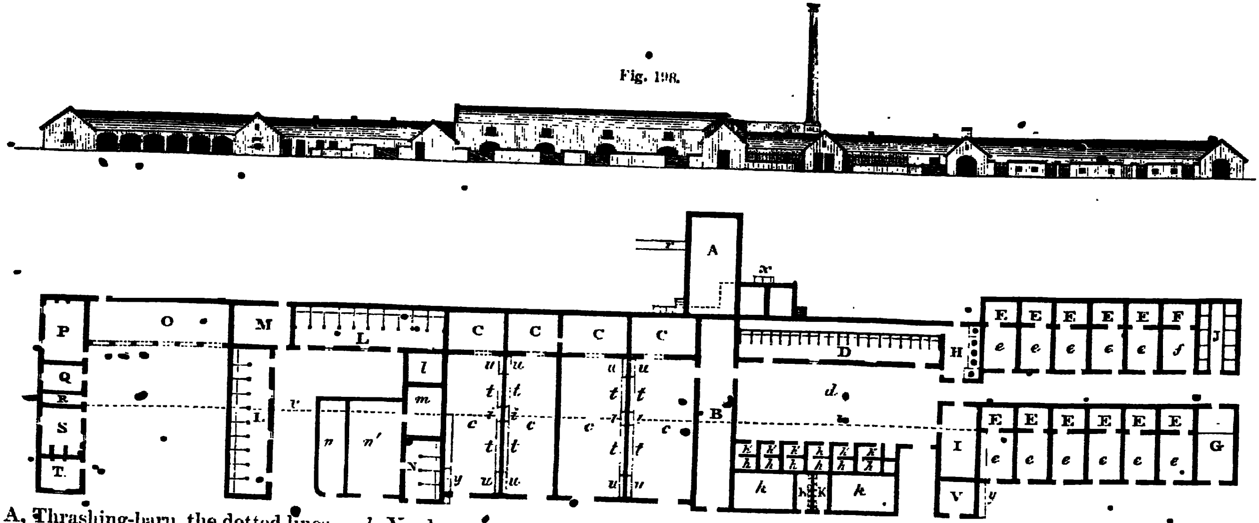
The extent and arrangement of the different parts of farm-buildings depend on the nature and size of the farm, and on the species of management to be pursued upon it. The principal parts of the farm-buildings, are, the barns, the stables, the cow-houses and other feeding-houses, the shelter-sheds, the granary, and the cart-shed.

Figure 198, which is the ground-plan and elevation of a set of farm-buildings, is designed to illustrate the general principles of the arrangement of this class of buildings, without showing those deviations which circumstances may require, or those details of practice which demand the attention of the architect. The size and arrangement of the buildings here shown are intended for a farm of the larger class, and have a direct reference to the species of agriculture which has been explained in this work.

The most convenient disposition of the out-houses of a farm, suited to a mixed system of tillage and the feeding of live-stock as practised in this country, is in the form of a long rectangle, open at one side, generally to the south, so as to admit the air to the cattle in the yards, and allow sufficient sunshine to them in winter. This is a point of practice which demands the more attention, as scarce any error in the erecting of this class of buildings is more common with architects than to crowd the different parts of the buildings together, under the idea of giving to them greater compactness; as if a few square yards more, taken up in necessary buildings, were of importance upon a farm.

The Barns being the part whence the straw for fodder and litter is carried to the stables, feeding-houses, and sheds, they should be placed so as to afford the readiest access to these different buildings. It is common to place them as near the centre of the range as the general arrangement of the other buildings will allow. In the design in the figure, in which A

Fig. 198.



A, Thrashing-barn, the dotted lines showing the position of the thrashing-machine.
r, Gangway.
x, Engine-house.
B, Straw-barn.
C, C, C, C, Shelter-sheds.
c, c, c, c, Yards to do.
t, t, t, t, &c. Troughs for green food.
u, u, u, u, Racks for hay.
D, Cow-house.

d, Yard.
E, E, E, E, &c. Sheds } for feeding.
e, e, e, e, &c. Yards. }
F, f, Shed and Yard for bull.
J, House and pens for calves.
H, Boiling or steaming house.
I, Root-house.
G, Turnip-shed.
M. Hay-house.
L, L, Farm-horse stables.

N, Saddle-horse stable.
l, House for mare and foal.
m, Shed for colts.
n', Yard.
n, Stable dung-heap.
O, Cart-shed.
h, h, h, h, Shed } for pigs.
h', h', h', h', Yards }
K, K, Houses } for poultry.
k, k, Yards }

Q, Tool-house.
P, Carpenter's shop.
S, Smithy.
R, Coal-house.
T, V, spare rooms, one of which may be a House for bailiff.
i i, i i, Troughs for water.
v, v, Line of sewer.
y, y, Tanks.

and B represent the barns, this principle of arrangement is observed.

Where a thrashing-machine is employed, and upon such a farm as we are now considering, we may proceed upon that supposition, the barn for thrashing consists of two apartments, the one above the other. In the upper apartment is placed the unthrashed corn, as it is brought from the stacks. The sheaves are carried up to it by means of an easy gangway on the outside. At one end of it is the thrashing-machine, which extends down to the lower apartment. In the upper apartment is placed the table on which the sheaves are spread out, and the feeding-board at which the man stands who feeds in the corn. Below this apartment is that part of the barn termed the dressing-barn, into which the grain is received from the thrashing-machine, and where it is winnowed and prepared. Turning to Fig. 43, which represents the thrashing-machine, the space at M is that which corresponds with the upper apartment of the barn: that at N with the lower part or dressing-barn. In Fig. 198, A is these parts of the barn: and connected with them is the house *x*, for the moving power which we may suppose to be steam.

Connected with these apartments is a long building, termed the straw-barn. In this the straw is received as it falls from the machine, and is piled or stored for use. This building should be of sufficient size to contain the produce of two stacks or more. To allow sufficient space for this purpose, it is better that there be no loft or granary in this apartment, but that the whole space, from the floor to the roof, be left free. In the figure B is the straw-barn.

Adjoining the thrashing-barn should be a granary, for the purpose of holding corn and seeds of all kinds. On no large farm can a granary be dispensed with. It is usually an upper apartment, and may extend over any convenient portion of the building near the corn-barn. In the design in the figure, it extends over the shelter-sheds, C, C, C, C.

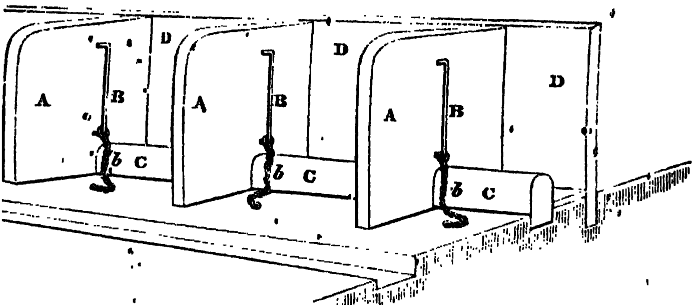
The Shelter-sheds are open sheds, which have yards in front. In these yards are placed moveable racks (Fig. 186) for holding the straw, or other dried provender, which the animals receive; and there may be fixed racks, for holding hay. There is further placed in the yards troughs of wood or stone for containing the turnips or other roots given to the stock; and in every yard there should be a trough for containing water. In Fig. 198, *t t t*, &c. are the troughs for containing green food; *u u u u*, the racks for hay.

The Cow-houses should be laid out with attention to ventilation and cleanliness. They should be causewayed, with an open channel behind the animals, having such descent as to carry off the liquid.

The common method of attaching cows in these houses, is to upright posts placed in a row, at the distance of about 2 feet from the wall. Round each post is a moveable ring, to which is attached a chain which passes round the neck of the animal. When attached in this manner, a space of 4 feet between each post will suffice. The space seems to be confined enough, and yet experience shows that large cattle may be confined in a still narrower space, without apparent inconvenience. The animals feed from a low manger, formed for the most part merely by a raised ledge of stone 6 or 8 inches high, between which and the wall the food is placed. Sometimes there is a narrow pathway between this manger and the wall of the building, by which the food can be more easily placed before the animals: and this is a convenient and proper arrangement, though it increases somewhat the expense of building, by enlarging the size of the roof.

Sometimes a yet more perfect system is adopted. Each cow has a separate stall, the stalls being divided by low partitions formed of flat stones or boards, of just sufficient size to keep the cows from interfering with one another. To these partitions are fixed vertical rods or bars of iron, moving upon each of which is a ring, to which is attached the chain which passes round the neck of the animal: and, further, these stalls are divided by low partitions from the pathway along which the food is conveyed. The following figure represents this method of construction.

Fig. 199.



Here A A A are the partitions between the cows; B B B, the upright iron rods, to which are fixed the rings and chains *bbb*; C C C are the raised edges or curb-stone of the mangers; D D D are the low partitions separating the mangers from the pathway by which the food is conveyed to the several stalls, the food, of whatever kind, being thrown over these partitions into the mangers. The same species of stalls may be applied to the feeding of oxen.

In Fig. 198, the cow-house D is placed next to the barns, and shows the arrangement of stalls here described. There is a yard in front, to which the cows may be turned out for a short time in the day for air and water.

The feeding oxen may have houses of the same construction. But oxen may also be fed in little yards, and sheds attached to which they can retire; and this is an improved method of feeding even the finest and largest oxen. In each yard should be a trough for holding the turnips and other food. Where turnips are used, no water is required, but where dry food is employed water should be in every yard. In the figure two ranges of these sheds are shown, E E E, &c. being the sheds, *e e e*, &c. the yards. One of these sheds and yards F *f*, may be used for holding the bull: another J, made into a house for calves receiving milk. Should close houses and stalls be preferred, these may be substituted, the arrangement of the other buildings remaining as before.

Connected with the cow-house and feeding places, there may be a house for steaming or boiling food. A convenient position of this house is H, as shown in the figure. Adjoining to this may be a house I, for containing potatoes and other roots, and it is convenient also where turnips are employed in feeding, to have covered sheds in which a certain quantity of turnips may be put for present use. In the figure, G represents a convenient position for these sheds.

The stables must be of a size sufficient for the number of horses employed in working the farm. Each horse should have his own stall. There should be a range of racks above for holding hay, and a manger with a sparred bottom below for holding green food, as tares and clover, and a close manger for holding corn and steamed food. It is better, for the thorough ventilation of a stable of this kind, that there be no hay-loft above, but that the whole space to the roof be left free.

Connected with the stables, may be a house for holding hay for present use. In this is kept a store of hay, to prevent the necessity of going constantly to the hay-stack, when hay is wanted; and this method of keeping it is convenient, by obviating the necessity of a loft above the stables. In the figure, M is the hay house, and L L the stables on each side of it.

Besides the stables for the work-horses, there ought to be on every considerable farm a stable with a few stalls for saddle-horses. Every occupier of a large farm must have a horse, as essential to economy of time in his business, and there should be a spare stall or more for young horses in the course of training. In the figure, N is the saddle-horse stable. In the figure are further shown a spare house for a mare and foal *l*, and a shed *m* for colts, open to the yard *n'*: in which yard, or in an adjoining one, *n*, is also deposited the dung from the different stables.

One of the necessary houses of the farm is a shed for holding the implements. This is made of a size to contain the carts, ploughs, and other implements, when not in use. In the figure, O is the Cart-shed.

On every farm there should be sufficient accommodation for the swine. The houses for this purpose may consist of little sheds opening on small yards. These may be disposed in any part of the range of buildings which shall be convenient. In the figure, *h h h h* are the sheds, and *h'h'h'h*, the open yards in front; but the number may be extended to the degree required.

A poultry house or two with yards may also be erected, one for the gallinaceous, and one for the web-footed fowls, though one house and yard properly arranged will generally suffice. In the figure, KK are the poultry-houses, and *k k* the yards.

On a considerable farm, too, there ought to be a small locked house for holding tools, as saws, planes, hatches, and the like. This not only preserves these smaller implements, but keeps them in one place, and prevents loss of time in searching for them. Q in the figure is the Tool-house.

On any large farm, it is also convenient to have a carpenter's and blacksmith's shop, at which workmen may be employed when required. A good deal of time will be saved by these means, when the blacksmith and carpenter reside at some distance. In the figure, P is the carpenter's shop; S the smithy; and R a small house for containing coals.

On a large farm, too, there should be one or more spare rooms, there being many little things to be done upon a farm which cannot be classed under any general kind of work, and for which it is convenient to have separate apartments. In the figure, the spare rooms are marked T and V. It may be well, too, that a trusty person reside at some part of the range of buildings.

An important point to be attended to, is to convey the necessary supply of water to the different yards. When the supply is obtained in sufficient quantity from a running stream, little difficulty exists in conveying it to the troughs in the yards and other parts of the buildings. But when water must be raised from a well, it should be conveyed in the first place to a large cistern, raised to the necessary height, so that it may be brought from this cistern in pipes to the smaller cisterns or troughs. The supply can be nicely regulated by means of ball or floating cocks in the troughs, so that none of it shall be wasted. In the figure *i i*, *i i*, are the troughs in the larger yards. There should be similar troughs in other parts, as one in the yard *n'* for the colts, one or more in the yard *d* for the cows, and, when the oxen are fed on dried food, a number to supply each of the yards, *e e*, &c.

Another object not to be neglected is to convey away the surplus liquid of the stables and feeding-houses. This may be done either by drains under ground, or by open paved channels, and these should lead to a common sewer or discharging conduit, which should be of sufficient height and width to allow a person to go up it and clean it. This general conduit should lead to one or more tanks or basins to which the liquid may be conveyed. Either this liquid may be pumped up from the tanks, and conveyed in barrels to the ground to be manured, or the tanks may have earth, litter, and other substances placed in them to absorb the liquid. The direction of the large sewer is shown by the line *v v*, in the figure, and is laid out on the supposition of the ground being flat. Should it be otherwise, it must be laid out to suit the inequalities of the surface. The letters *y y* show the situation of the tanks.

These various buildings, it is to be kept in mind, are designed for a farm of the larger class, and where the accommodation is supposed to be complete. When the farm is smaller, not only may the different buildings be diminished in size, but several of them may be dispensed with. It is to be observed, however, that although on a smaller farm the same accommodation is not required as on a large one, yet the buildings cannot be reduced in proportion to the diminished size of the farm. Small farms, accordingly, always require a greater comparative extent of building than large. The buildings, too, of which this general description has been given, are designed for a farm partly employed in breeding, and partly in feeding. Deviations from the general design, therefore, will be rendered necessary, in the case of peculiarities affecting the mode of management.

Thus, a farm where the main purpose is the dairy, will require increased accommodation for the milch cows, and less for other kinds of cattle. The chief object of attention in a dairy farm being the milch-cows, the accommodation for them should be commodious and complete. Ventilation, cleanliness, and water, are essential to the health of animals so much confined as the cows of a dairy. The dairy itself, or the houses *for preparing the milk, should be at some distance from the cow-houses* and effluvia of the yards, and either connected with, or very close to, the dwelling-house.

When a farm is near a large town, the buildings must be suited to this peculiarity of situation. On such a farm, the rearing and feeding of live-stock may not be carried on at all, and only the raising of vegetable produce for sale attended to. The buildings required for such a farm need be few and simple. No feeding and shelter-sheds are required, and there is no need of that extension of the range of buildings which is necessary in the case of a rearing and breeding farm.

Another class of farms, again, may be purely stock-farms. On this class comparatively few buildings are required. These are principally sheds for shelter to the young cattle, and low sheds with yards for penning sheep when occasion requires. There should be a spare house or two for different purposes, as for holding wool, the extent and nature of which will depend entirely upon the kind of farm.

Besides the out-houses of the farm, there are required a dwelling-house for the farmer and houses for his labourers. The farm-house, in extent and accommodation, must generally be suited to the circumstances of the occupier; and the labouring man, when he resides upon the farm, should possess, in so far as his cottage is concerned, those decencies and comforts which are suited to his condition.

II. ARTIFICIAL DIVISIONS OF THE FARM.

Where a country is entirely in tillage, it is of less importance that farms be divided by artificial barriers; but wherever live-stock is kept, this is essential to the proper keeping of the animals, and to the profitable occupation of the grounds; and besides the purpose of retaining and separating animals of different kinds from one another, and of defending the cultivated crops from injury, fences serve the purpose of sheltering the fields, and, when accompanied by ditches, of draining the ground.

The fences of the farm may consist either of stone-wall, or of live-fence, or of a combination of the live-fence and stone-wall, and sometimes even of an open ditch, a mound, or a rail.

The stone-wall may either be formed of stones built without cement, or it may be built with mortar like common masonry. But the last of these methods is rarely practised with the common fences of a farm. The cementing of the stones with mortar adds, indeed, to the durability of the wall, but then the expense is too great in common cases. The wall, therefore, for the ordinary purposes of the farm, may generally be built of stones alone, though sometimes with a little mortar merely for cementing the coping, and occasionally for pinning or closing the interstices of the outside. When stones cannot be obtained, brick may be substituted.

The materials for building the dry-stone wall, as this kind of wall is termed, may be sandstone, whinstone, or any other stones of sufficient durability. Loose stones taken from the surface, termed land-stones, answer sufficiently well, if they be of proper size, and not too much rounded: but in the latter case, they present too smooth a surface, and cannot be kept in their places without mortar.

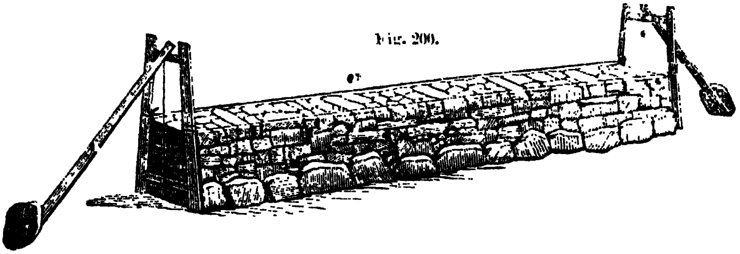
The implements to be used in building the dry-stone wall are, a mason's hammer, a spade or shovel for clearing the ground for a foundation, a pick or mattock, and a frame of two upright posts fixed together, so as to correspond with a vertical section of a portion of the wall. (Fig. 200.)

The line of the intended fence being fixed upon and marked on the ground, the stones for building should be brought forward, and laid down on both sides, if possible, of the line of fence, but if not, on one side.

Pins being fixed in the centre of the space to be occupied by the wall, the workman proceeds thus:—He carries his wooden frame to some distance along the line to be built upon;

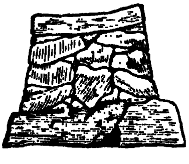
he sets it perpendicular, which he is enabled to do by means of a plumb-line attached to it, and he fixes it in this position in a simple manner, as shown in the figure. He then fixes another similar frame at the place where the wall is to commence; he stretches two cords between these two frames on the outside, and as these cords correspond with the outside of the wall at a given height, he has a guide for building it of the required dimensions. After having built one portion, he uses only one frame, the wall itself serving afterwards the part of a frame; for the cords being fixed to both sides of the wall, and then attached to the frame which is placed in advance, the workman has, as before, a guide by which he proceeds in building.

Fig. 200.



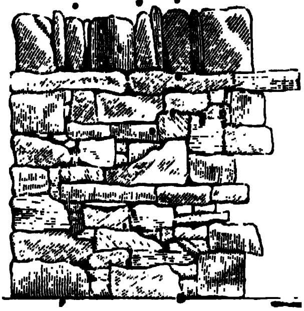
The foundation of the wall should be laid on firm ground, and when there is not green sward to build upon, the loose earth should be taken out by the spade, until a solid foundation is arrived at. In building, the largest and flattest stones should be used for the foundation; and it is very desirable, if the materials used will allow, to place stones at intervals of sufficient size to lie across the breadth of the wall, so as to bind the wall together, and render it more secure. (Fig. 201.)

Fig. 201.



Different kinds of coping may be placed upon the wall, to defend it. One of these consists merely of turf, two sods being laid upon the wall, with the earthy sides placed towards each other. Another species of coping consists of large stones, which, being closely built and wedged together, are cemented by mortar. This is a complete and durable species of coping; but when it is used, a row of flat stones should be laid on the top of the wall immediately beneath the coping, and made to project a little on each side of it. (Fig. 202).

Fig. 202.



A wall, sufficient for the purposes of the farm, may be 32 inches wide at bottom, 16 inches wide at top, and, including the coping, 4½ feet high. Such a wall, exclusive of the expense of procuring and bringing forward the stones, may be built at from 4½d. to 5d. the yard in length, at the present rate of labour in this country; and 2 good cart-loads of stones will suffice for building a yard.

The advantages of the stone-wall, as compared with the live-fence, are, that it becomes useful as soon as made; that it can be formed in situations so unfavourable with respect to soil and climate, that the thorn and other plants cannot be raised; that it requires no nursing, nor the other expenses of cleaning and pruning which attend the live-fence: that it is not injured or destroyed by the trespasses of sheep and other animals, as the live-fence frequently is in the early stages of its growth: and that it occupies little room, and does not injure the growing crops by harbouring birds and other animals. For these reasons, there are many cases in which the stone-wall is the best species of fence. It is in an especial degree suited to an elevated country. Nothing, indeed, is more to be desired in such a country than to obtain shelter; and live-fences, where they can be reared, afford a certain degree of shelter, by breaking the force of winds. But as live-fences grow for the most part feebly in very elevated situations, they there perform but imperfectly the purposes of shelter. In such cases, shelter is better obtained by the planting of wood, which is superior to fences in affording the means of improving the climate of a bleak country.

But, again, the live-fence, accompanied with ditches, has its advantages in the situations where it can be reared. Not to speak of it as an object of beauty, in which it far surpasses the stone-wall, it affords shelter, and, in combination with the ditch, the means of carrying off water from the ground.

For this kind of fence, different plants of the Rose family are employed. These are armed with sharp spines, and, branching out in innumerable directions, form dense bushes. Of these plants, the most esteemed is *Cratægus Oxyacantha*, the Hawthorn.

The hawthorn is easily produced from the seeds of its fruit or haw. It is best raised in the nursery, and, after being 2 years transplanted from the seed-bed, in the manner of forest trees, planted in the line of the fence.

The ground upon which thorns are to be planted, should undergo a complete preparation by deep ploughing, or trenching with the spade, and by a thorough manuring. Attention to this preparation is very important, and will, in many cases, constitute the difference between success and failure in forming a thorn-fence. When the ground is tolerably full of vegetable matter, lime may be used as a manure. But where the soil is poor, both lime and dung should be employed, and it is generally advantageous to apply them twelve months or more before the thorns are planted.

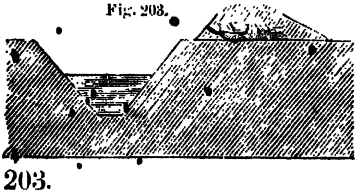
Having fixed upon the line of the fence, it may be laid off by means of poles, like the ridges of a field, and marked upon the ground. The instruments used in the practical operation are a common reel and line, like that of gardeners, and a rod of wood of about 6 feet in length, divided into feet and inches, with a piece of wood fixed at right angles to the end of it, so as to measure off with facility the breadth of the ditch, in a direction perpendicular to the line laid down. The instruments for working are a common spade, a narrow-pointed shovel, a common mattock, and a foot-pick.

The line of the side of the ditch along which the thorns are to be set, being marked out by the rod and line, and notched by the spade, the workman takes off a part of the earth from the surface of the intended ditch, and lays it along the future line of thorns, this earth being laid about 6 inches back from the notched line, so as to leave what is called a scarcement; or, if there be sward, a row of sods are in like manner to be laid 6 inches back from the notched line, with their grassy sides undermost. He then beats down the earth or sods thus laid with his spade, so as that the outer surface shall be in the line of the future mound, and sloping a little backwards in the manner shown in the following figure, so that they shall be highest next the ditch. It is upon the row of earth or sods thus placed, technically termed the thorn-bed, that the thorns to be planted are laid. A further portion of the surface of the ditch is then stript off, and thrown behind the thorn-bed.

The thorn plants have, in the mean time, been prepared in the following manner:—Each plant, with its roots and fibres as taken out of the ground, is grasped by one hand, while, with a sharp knife, the stem is cut through by a cut inclining upwards, so as to leave, exclusive of the root, about 8 inches of the stem. The plants being thus prepared, may be put in the earth again until they are ready to be planted. This is done that they may be protected from frost, for the process of planting being performed in winter, every precaution is to be employed to prevent the young plants from being injured.

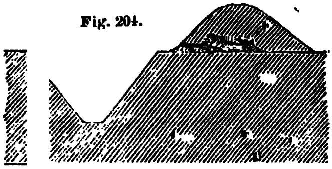
When a sufficient space of ground is ready for being planted, the plants are to be placed firmly upon the thorn-bed, so that, when the mound is made, they may project a very little beyond the surface, or rather just reach it. The distance at which they may be planted from one another, may be about 8 inches. While one or more persons are employed in laying the thorns, another is to shovel up from the ditch the loose mould immediately next the surface, and place it upon the stems of the plants. This earth, being compressed by the foot, the plants will be firmly fixed in their position, and so covered as to be out of the reach of danger from frost. A section of the bank will appear at this stage of the process, as in Fig. 203.

Fig. 203.



A considerable portion being done in this manner, the ditch is to be cleared out to its full depth, and the earth thrown upon the bank. The mound is then to be rounded at top, and beat all around by the shovel. A transverse section of the work when finished will appear as in Fig. 204.

Fig. 204.



This completes the formation of the hedge and ditch. The ditch should be narrowed to a spade-breadth at bottom, and the sides made to slope at an angle of 45°. The mound will occupy a somewhat larger space than the breadth of the ditch. The ditch must be so laid out and formed, as to permit the descent of water. Where there are slight inequalities, it must be made deeper at one part than another, and if necessary, the earth must be wheeled away from the part where the ditch is deep, to make up the mound where the ditch is shallow; and sometimes, in the case of passing a hollow place, the water must be carried away by a drain, cut through the mound and underneath the thorns into the adjoining field.

It is a very common practice in making the ditch and hedge, to leave the scarcement or little space between the thorns and the edge of the ditch: but some do not approve of this scarcement, conceiving it to be unnecessary, and to favour the growth of weeds. The advantage, however, of leaving the scarcement is, that it tends to prevent the earth from falling down into the ditch, and leaving the roots of the plants exposed.

The proper time for performing the operation of planting, is from October to the beginning of March, that is, during the period when vegetation is inert.

Following the practice that has been described, failure will be rare, except in situations entirely unsuited to the growth of the thorn. The plant, it will be seen, is set on mould in a manner best suited to favour its growth: and the stem being laid nearly horizontally and covered with earth, shoots forth fibres at every part, and becomes itself a root.

In place of one mound and ditch formed in the manner described, two ditches are sometimes formed, with a mound between, and two rows of thorns. This kind of fence, however, is only mentioned that it may be condemned. It occupies more room than the single mound, creates nearly double the expense of management, and is not so favourable to the growth of thorns. The only case in which a double row of thorns and ditch of this kind should be formed, is in hollows, where two ditches are required for carrying off water.

The fence, then, as described, is a mere bank of earth with a ditch, which animals can pass over. In its first stage, it forms of itself a feeble barrier, and is subject to be destroyed by animals passing over it. It must, therefore, be defended until it becomes an effectual barrier; and this is done by means of rails or paling.

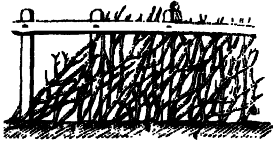
Paling consists of horizontal rails, nailed to posts or stakes, placed vertically, and driven into the ground. It may be made with either two or three horizontal rails. The latter number is preferable, and necessary where sheep are feeding.

The rails are formed either of sawed or split wood. When the trees are small, they may be split, but when they are of sufficient size they should be sawed, for this makes the neatest and most durable paling. Wild pine, spruce, larch, or any other of the pine kind, will answer: and the quantity of these trees in all parts of the country is now so great, that they can be every where obtained with facility, and at a low price.

Of the same material the stakes are formed. These are made about 4½ feet long, and sharpened to a point. They are driven into the ground with a mall to the depth of about 15 inches, and set at the distance of 5 or 6 feet from one another. The horizontal rails are attached to them by stout nails.

Another species of temporary fence, which may sometimes supply the place of paling, is formed in the following manner:—Posts or stakes, as for paling, are driven into the ground, and branches of trees, or brushwood of any kind, are warped or wattled round the stakes. The butt-ends of these branches are placed upon the ground in warping them, and an inclination is given to them as in the figure. A light spar along the top will render this species of fence very complete. It will last as long as paling, and is more economical, since the bushes and branches are of little value.

Fig. 205.



One set of paling will generally last sufficiently long to allow the fence to attain to the necessary height and strength. It is to insure this that the paling should not be put up sooner than is really required, so that, if the land be under a course of tillage, the paling need not be put up until it is again laid down to grass.

The rails for the protection of the fence may be placed upon the top of the mound. This forms an effectual barrier, in so far as it prevents animals from passing over; but it does not prevent animals that may be pasturing on the thorn side of the field from reaching the young plants. They will rarely, indeed, do much injury, unless they pass over; but all injury may be guarded against, by placing a row of paling along the edge of the ditch itself, so as to prevent access to it. In this way, indeed, there are two rows of paling, which increases the expense; but these rows need not in this case have each more than two bars, and if it is important to rear an efficient fence, without the risk of failure, it may be better to do the work in this manner. For the most part, however, when there is a good ditch, one row of paling of three bars on the top of the mound will be found sufficient.

The hedge, mound, and ditch being formed, there is next to be considered the manner of managing the fence. The implements required for this purpose are, first, those for weeding, and second, those for cutting or lopping the branches or twigs.

For the first of these purposes, that of weeding, a simple instrument will suffice, namely, a small spade, usually termed a hedge-spade, with a handle about 3½ feet long, and a blade about 5 inches broad (Fig. 208).

The instruments used for lopping or cutting may be three:

The first is a slightly bent knife fixed to a handle, for cutting off the ends of the twigs or branches by an upward stroke (Fig. 207); or in place of this may be employed shears; but the knife, it is conceived, is equally efficient, and more expeditious.

The next instrument is one of the same form, but of greater weight, and with a shorter and more slightly curved blade (Fig. 206). This instrument may weigh about 6 lb.; it is employed for cutting through the stems of thorns. The other instrument is a light axe, which is employed for the same purpose.

Fig. 206.

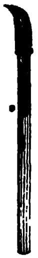


Fig. 207.

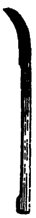
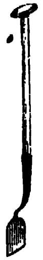


Fig. 208.



The first object of attention, after the thorns are set, is the young plants, which, we have seen, have been buried in the ground, with one end just projecting to the surface. These will generally pass through to the day when they have begun to grow, but should they not be able to make their way through, the earth is to be gently stirred with the hand or a stick, so as to open a way for them, taking care, however, not to rub off any of the buds.

During the first year of their growth, the plants will require little cleaning, and no pruning. Should weeds, however, spring up in quantity in the first year, they must be hoed down. The manner of hoeing is simple: The hedger, with his small spade, stands in the ditch, and with light horizontal strokes cuts down the weeds about the thorns. He may also, if necessary, proceed along the top of the mound, and, working downwards, cut such weeds as he may not be able to reach from below.

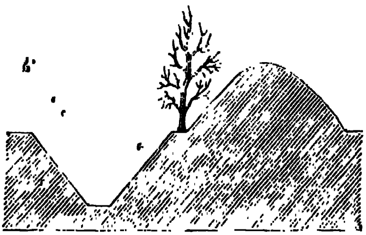
After this, the same process of cleaning should be performed at least once every year, and generally twice. The work may be done at any period in the year when the weeds are growing; but when the fences are young, it is a good rule to perform the operation before the weeds rise in summer amongst the twigs of thorns.

The weeds that infest hedges are grasses of different kinds, of which the most troublesome and difficult to be extirpated is couch-grass. Other plants, as docks of different kinds, thistles, and chiefly the way-thistle, chick-weed, and dead-nettle, goose-grass, common rest-harrow, wild mustard, tufted vetch, and many others, form the common weeds of hedges.

The other process in the management of the hedge is that of pruning. This is intended to cause the plants to grow bushy and thick, so as to form a barrier to animals. It is simply performed by means of the light knife (Fig. 207).

During the first year of the growth of the hedge, it will require, it has been said, no pruning; the second year, after the fall of the leaf, pruning may be begun; and it is to be observed, that in all cases of pruning, the proper season is when vegetation is inert, and not when the sap is ascending. The thorns at this stage are to be pruned lightly, with an upward stroke of the knife, a small portion also of the shoots of the top being lopped off. The same process is to be annually repeated, keeping the whole narrow at top, broad near the bottom, and inclined from the bottom upwards in the manner shown in Fig. 209.

Fig. 209.



When the thorns, under this system of yearly lopping the lateral branches, and slightly cropping the top, have reached the height of 4 or 5 feet, two methods of management may be adopted. Either the whole may be allowed to grow to the height to which it will naturally grow, the only further pruning being to cut off such of the lateral branches as are overshadowing those beneath; or the process of pruning may be continued yearly, so as to keep the hedge at the proper height, namely, 4 or 5 feet.

This, then, is the simple management of the thorn fence:—It is, or ought to be, every year weeded once or twice; and it is to be regularly pruned, so as to render it bushy, until it gets to a certain height, when it may either be allowed to grow up to its full size without further pruning, or be kept by an annual pruning at a uniform height. The former method is sufficient with the fences of a farm, but the latter makes the neater and more bushy fence, although it is the more expensive.

Under this management, the fence will continue vigorous for a long period. But when at length, from any cause, it gets thin at the root, or shows symptoms of feeble growth, or when, having reached its natural size, the lower lateral branches begin to fall off, a simple method of renewing it is to be practised.

In this case, the whole thorns are to be cut down to within a few inches of the ground, employing either the heavy cutting-knife (Fig. 206), or, when the stems are very strong, the axe.

In employing the cutting-knife, the hedger stands in the ditch with his right hand towards the thorns, and cuts upwards with a back stroke with his right hand. The stroke must in all cases be made obliquely upwards and not downwards; for the effect of the latter method would be to shatter the lower part of the stem, and subject it to injury from wetness. When the axe, instead of the knife, is used, the workman stands in a different position. His left hand is now next the hedge, and he uses both hands in cutting; the stroke, however, as before, being made obliquely upwards. But it is only when the stems are very thick and old, that the knife will not effect the purpose.

When the thorns are thus felled to within a few inches of their roots, the ground around the stems is to be carefully cleaned by digging; and the further operation to be performed is to clean out the ditch, and replace before and around the thorns the earth which had been drawn into the ditch by continued weeding. The stocks of the thorns will now be nearly covered to the top. Fig. 210 shews the state of the fence before the ditch is cleaned out; and Fig. 211 when the operation is completed.

Fig. 210.

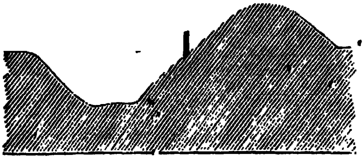
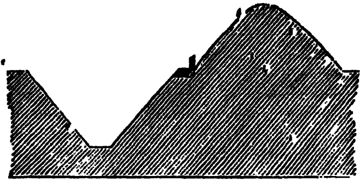
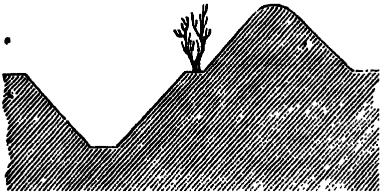


Fig. 211.



In a very short time after this operation, shoots will spring from the old stems with vigour, and thus the fence will be restored, when it will appear as in Fig. 212. There may be cases indeed, in which shoots will not spring from the old stocks. This indicates that the hedge has lived its natural term, and is the irremediable effect of age; but in all cases in which the hedge possesses sufficient vigour, this method of renewing it will be attended with the effects desired.

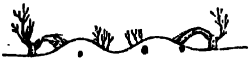
Fig. 212.



And in cases in which a thorn hedge is seen to have suffered from previous neglect, this simple mean may be employed to restore it. In this case also, the opportunity is taken to fill up blank spaces in the line of the thorns. For this purpose, the earth in the blank spaces should be completely taken out, and the spaces filled with fresh soil; and in place of the hawthorn, the crab may be planted, as being better calculated to succeed under such circumstances.

In place of planting new thorns to fill up a blank, a practice sometimes resorted to is, in the second year after the new shoots have sprung up, to take one of them on each side of the gap, and, bending them down, to fix them with a crooked stick, to the ground, in the manner practised by gardeners. Some earth being then laid upon the twigs, they will soon spring up,

Fig. 213.

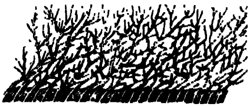


and fill the interval of the gap, especially if the earth of the gap has been filled with new soil, well dunged and limed. A gap renewed in this manner will appear as in the figure.

When hedges are lopped down to the ground in the manner described, they must be protected until the new shoots have attained a certain size, as in the case of new fences. But it is not usually necessary to have recourse to paling, because the thorns cut down furnish themselves material for forming a sufficient fence, termed a dead hedge.

A dead hedge is thus formed:—The workman cuts the stems of the thorns into lengths of 3 or 4 feet. He forms bundles of these, mixing with them the smaller twigs, and compressing them so that they shall adhere together. Another person with a spade, working on the line which the dead hedge is to occupy, takes up a sod or spadeful of earth; and a bundle of twigs being handed to him, he places the but-end of the bundle in the hole made by the spade, and leaning against the earth thrown out. He then lifts another sod or spadeful of earth, and places it upon the but-end of the first bundle, compressing it firmly with his foot; and in this manner he forms the line of the fence. The fence, when finished, appears as in the figure; and a proper situation for it is on the mound immediately behind the thorns.

Fig. 214.



The plant which has been especially referred to as calculated for the hedge, is the hawthorn. But there are two other plants, similar in appearance, which are sometimes cultivated, either separately or intermixed with the hawthorn. These are, *Prunus spinosa*, the Sloe, and *Pyrus acerba*, the Wild Apple or Crab. Both of these plants grow readily, and bear cutting, but they are not so well suited for cultivation for hedge-plants as the hawthorn.

A plant sometimes cultivated for hedges, though destitute of spines, which so particularly fit the hawthorn for its purpose, is the Beech, *Fagus sylvatica*, which forms a tolerably good fence, from the mass of twigs which it sends forth when it is restrained in its upward or lateral growth by pruning. The Hornbeam, too, *Carpinus Betulus*, is equally well suited for the hedge as the beech, and is sometimes cultivated for that purpose.

The properties which fit the beech and the hornbeam for the hedge are, the facility with which they can be produced, the manner in which they bear pruning, and their fitness to grow on land somewhat low in the scale of fertility. Sometimes the beech is mixed with thorns, every second or third plant being a beech. Good fences may be produced in this way, but, in general, the simple thorn is the best defence against cattle, and an intermixture of other trees and shrubs injures its utility. The beech and the hawthorn being of irregular growth, and the beech the most rapid, the latter tends to prevent the growth of the thorns, and often extirpates them altogether.

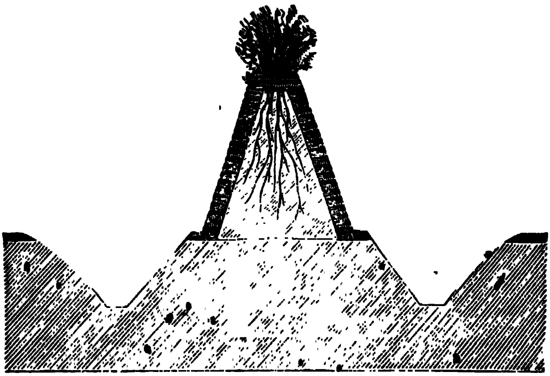
The Alder and the Willow form tolerable fences on marshy ground, and grow on soils where the hawthorn could not be produced; and they may thus, in some cases, be beneficially substituted for the thorn. They may be twisted together, for which their pliable branches peculiarly adapt them.

The Holly, *Ilex Aquifolium*, has in some cases been substituted for the thorn. It makes an impenetrable fence, bears cropping well, and its verdure does not suffer in the severest winter. The objections to the culture of this hardy plant are, the slowness with which it grows, and the difficulty of raising it. The holly, indeed, does not grow so quickly as the thorn, but yet it can be raised in most situations if proper care be bestowed. Not bearing transplanting well, it may be raised from seed on the spot where it is to grow.

Another plant, indigenous, easily cultivated, and growing even on moors, armed too with spines, and an evergreen, will suggest itself as a fitting plant for the hedge: this is the Common Whin or Gorse, *Ulex europæus*.

A hedge of whin may be formed thus:—A mound (Fig 215), is to be made 6 feet broad at bottom, 20 inches wide at top, and about 6 feet high. Each side is to be built firmly with sods, taken from the spot, the middle is to be filled up with loose earth, and the top rounded over. A shallow ditch is to be left on each side of the fence with an interval or scarcement of 10 or 12 inches between the ditch or wall of sod. The whin-seeds are to be sown along the top of the mound, while the earth is yet fresh and moist. A pound of seeds will sow about 200 yards, and the best season for sowing the seeds, and consequently for making the fence, is during the months of March and April. This species of fence becomes complete in the second year after it is made, and therefore requires no rails. The whins should be pruned once every year: upon attention to this the success of the hedge mainly depends; and the proper period of pruning is in the month of June. The whin-hedge formed in this manner, is one of the cheapest fences that can be made. The roots of the whins will penetrate through every part of the mound, and prevent it from crumbling down, and the dense bush, formed at the height of 6 feet, will be sufficient to prevent the wildest sheep and cattle from passing over.

Fig. 215.

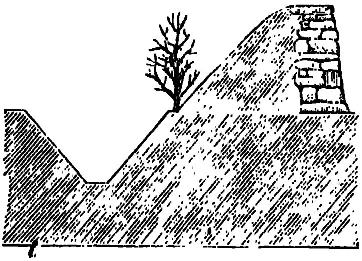


With this facility of growth, cheapness of production, and seeming fitness of the plant for its purposes, it will reasonably be inquired why it is that the whin is so little used as a hedge-plant in this and other countries. The chief reason is unfortunately a good one—the want of durability. Although a native, and, under certain circumstances, hardy, it is very apt to be destroyed by frost. It cannot, therefore, be depended upon as a permanent fence. Its duration indeed can be greatly prolonged by regular pruning, but, under the best management, the whin is comparatively of short duration as a useful fence. When, however, a cheap and immediate fence is required, without especial regard to the time it is to last, the whin will answer the purpose well.

The fences described are the stone-wall and the live-fence; but sometimes the two may be combined together, and form efficient fences.

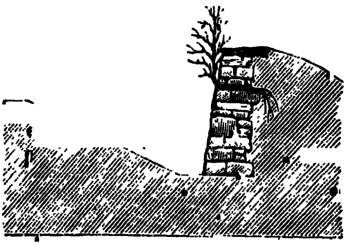
The most common of these is formed in the following manner:—A mound and ditch are to be made in the way already described, but the one side is to be a wall of stone, of half the breadth of a common wall, and 4½ feet high, as shown in the figure. This fence is therefore secured on one side, and requires only a row of two-bar paling on the other side to secure the hedge in its young state.

Fig. 216.



Another species of combined fence is what is termed a sunk fence, faced up with a dry-stone wall, as in the following figure. The base of the wall is 2 feet, and on the top is laid a coping of turf of 1½ foot thick. The thorns, when the wall has reached the proper height, are laid horizontally, and the stones so built that there shall be an aperture for each thorn, at the distance from one another of 9 or 10 inches. The thorns laid in this manner will shoot through the apertures between

Fig. 217.



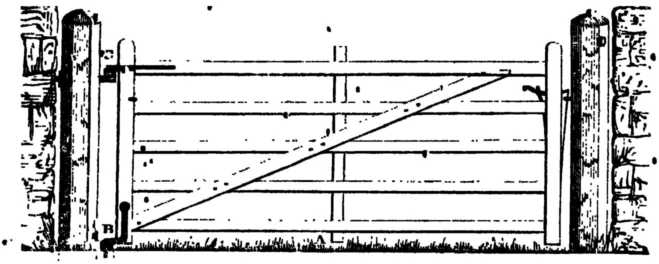
the stones. This kind of fence is suited to situations in which one side is safe from trespass, as round plantations; and as a security against any animals attempting to scale it, whins may be sown along the top of the mound.

Another point to be considered with relation to the fence is the Gate. The properties of a good gate are, that it shall combine with lightness the necessary strength, so that an equal quantity of materials shall produce the strongest gate. The strongest gate would be a solid piece of wood like a door; but this would not fulfil the other condition of lightness. Instead of the solid mass of wood, a set of horizontal bars will fulfil the purposes required. These bars must be at such a distance from one another as to prevent the passage of animals, and so connected as to be firmly bound together.

In the gate represented in the figure, there are five horizontal bars, connected together by a diagonal from the lower to the higher corner. This construction, it is conceived, will fulfil, sufficiently near for practice, the purpose of giving the parts of the gate the greatest strength with a given weight of materials. Sometimes upright braces are nailed to the gate, but these are not essential.

The gate may be hung upon two hinges; or the heel of the gate may rest in a socket placed in the ground, as in the figure. The bars should taper towards the fore part, so as to be lightest there, which diminishes the tendency of the fore part to fall down. For a gate, when we regard its tendency to sink down at the head, may be considered as a bended lever, of which the fulcrum is at B, the power at C, and the weight the centre of gravity of the gate, which, in the case of the gate being of uniform materials, will be represented in the lower bar at A. Hence by increasing the length of BC in proportion to BA, the power of the hinge at C to support the weight of the gate is increased; and this power is further increased when the gate is made heavier at its posterior part, so as to bring the centre of gravity nearer to B. In practice, therefore, the hinges should be kept at as great a distance from each other as possible, and the gate should be made light towards its anterior part.

Fig. 218.



In the figure there are shown five horizontal and two upright bars. The extremities of the horizontal bars are mortised into the two outer upright bars. The diagonal consists of a plank nailed to the one side, and abutting on the upper bar; and on the other side may be nailed an upright brace. The horizontal bars taper from the hinder part of the gate to the fore part. The length of the gate may be 9 feet, the height over the horizontal bars 3 feet 9 inches, the lower bar standing about six inches from the ground.

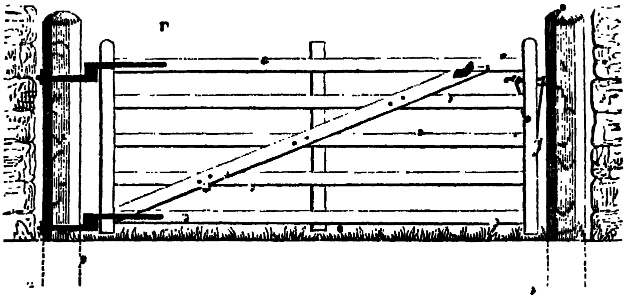
The posts may consist of wood, and should be well sunk in the ground; and any coarse kind of timber of sufficient strength may be employed; or, what is better, when they can be procured of the proper size, single stones of granite, greenstone, or any of the harder rocks. The band of the hinge should pass through the wood or stone, as shown in the figure, and be fixed by a bolt or screw-nut on the opposite side. The band of the latch and hinge should in like manner pass through the post or stone and be fixed by a screw-nut.

The latch may be of various forms; that shown in the figure is a spring of 2 feet in length, to which at right angles, as is more distinctly seen at *c*, Fig. 220, is fixed a piece of iron, which passes through the upright bar of the gate. This piece of iron, by means of two joints, acts as a lever when the hand is placed upon it, and withdraws the latch.

Sometimes it is convenient that a gate shall shut of itself when opened. A good gate of this construction is represented in Fig. 219. The upper hinge of the gate is fixed to the upmost bar, and is received into a socket in the hinge, as seen at *b*, Fig. 220. The advantages of making the upper hinge move in a socket are, that while space is given to it to move, it is firmly supported in its place; and that the means are afforded of causing it to move smoothly by pouring a little oil into the socket. The lower hinge is formed upon the principle of affording two pivots or points of support to the lower part of the gate. It consists of two iron plates placed horizontally, the one a little above the other, the upper being fixed to the post and the lower to the gate. From the lower part of the upper plate project two small cylindrical pieces of iron, placed perpendicularly as seen at *a* Fig. 220. These are received into the grooves or hollows of the under plate, so that the gate rests upon the two upright pieces of iron as pivots. The gate, when shut, has thus three points of support, namely, the socket of the upper hinge and the two lower pivots, the former of which is thus placed at the vertex, and the two latter at the base of an isosceles triangle; from which construction it results, that the gate is only in a state of equilibrium when, being shut, it rests upon both the two lower pivots; when opened accordingly it must tend to regain its former position.*

This construction, however, is not good in the case of the

Fig. 219.



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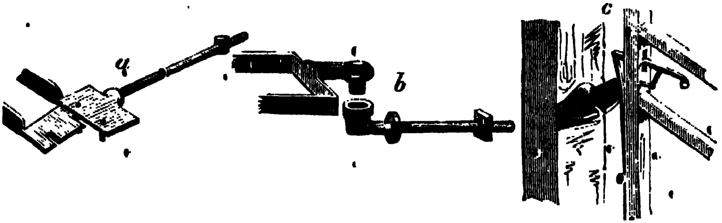
* Paper by me in Quarterly Journal of Agriculture.

Fig. 220.



ordinary gates of a farm. They are apt to be torn off the hinges by the passing of loaded carts.

All the mortises of a gate, and the parts at which the diagonal and braces cross the bars, should be carefully coated with white lead; and after the parts of the gate are joined together, the whole should receive two coats of oil paint.

Farm gates have sometimes been made wholly of hammered iron. The only objection to this kind of gate is, that it is apt to be bent. The wooden gate of a good construction answers its purpose as well as can be wished.

In speaking of the fence, I have said nothing of that which we are apt to associate with it, as its almost universal accompaniment, the hedgerow tree.

Were we to estimate the value of hedgerow trees by considerations of beauty alone, they would be beyond all price. Nothing gives so clothed and lively an aspect to a country as these beautiful objects; and the cultivated scenery of England is, on this account, amongst the richest any where seen. The taste for this species of planting in England is universal, and is riveted by habit and the earliest associations.

The practical farmer, however, feels from experience that in the hedge the forest-tree is out of its place. Its spreading roots interfere with and destroy the thorn, and its branches overshadowing it are also hurtful; and more than this, it extends the fibres of its roots into the adjacent fields, and, the branches overhanging the corn in its vicinity, exclude the air which is necessary for the healthy growth of plants, and the labours of harvest.

If profit, and not the gratification of taste is to be regarded, trees should be planted, not in hedgerows, where all the value at which they will arrive will rarely balance the yearly loss which they produce, but in groves, belts, or masses, where the trees will really become of value as timber, without injury to the fences and cultivated fields around. Were the loss sustained in England by the excessive multiplication of hedgerow trees to be reduced to calculation, it would exceed belief.

III. CAPITAL NECESSARY FOR THE FARM.

The capital necessary for a farm is the sum which a farmer must possess, in order that he may carry on his business. This partly depends on the customary degree of credit in a country. The farmer does not usually pay ready money for all the commodities he requires, but trusts to that degree of credit which is common in his business. And the same remark applies to almost every class of traders in this country. A merchant rarely limits his trade to the extent of his ready money, but trusts to that degree of confidence which exists ; and in this way the greater part of the trade of this country is carried on. In like manner, the person who enters to a farm may not find it necessary to possess all the capital which would be required were he to pay for every thing ; yet the nearer his funds approach to this condition, the greater will be his security. Too many engage in extensive farming on a loose and imperfect estimate of the funds required, and find, when too late, that they have miscalculated their means.

A want of the necessary funds is often more injurious to a farmer, than even an obligation to pay a high rent. With an inadequate capital, he is impeded at every step. He cannot render justice to his farm ; he must often bring his goods prematurely to market to supply his wants, and he will pay largely for the credit which he is compelled to seek. The farmer who has ready money at his command has, like every other trader, a great advantage over one who is forced to seek credit, and will be enabled to make a profit on many transactions on which the other would sustain a loss.

While, therefore, it cannot be contended that a farmer, who lives in a country where credit is the soul of commerce, is not to avail himself of this benefit, yet he must be careful not to miscalculate its effects ; and, at all events, and like every prudent man, he must make himself acquainted with the real amount of his pecuniary obligations. This is the true principle on which the capital required for a farm should be computed. The sum to be determined is that which the farmer has to advance, before a quantity of produce is raised upon the farm sufficient to replace the advance, and supposing all payments to be in money.

But the amount of necessary advances differs greatly according to the nature of the farm, the mode of management to be pursued upon it, the period of entry and the time of paying rents, the manner of paying labourers, and a multitude of circumstances dependent on local practice. To calculate the amount of capital, therefore, required in any case, it is necessary to limit the calculation, not only to a certain district, with a certain set of local customs, but to a given farm, managed in a given manner. All, therefore, that can be done, in the case of calculating the amount of capital required for a farm, is to give an example of the manner of making such a calculation under certain supposed conditions.

In the following calculation, the assumption is made of a farm situated in the south of Scotland. This district is selected, because there a beneficial combination exists of the practice of tillage and rearing live-stock ; because a good system is established with respect to the time and manner of paying rents and labourers ; and because the system of agriculture adopted there is in accordance with that which has been described in the present work. In giving the calculation of the farming capital required under the system adopted in this district, it will be necessary that its peculiar local usages be supposed adhered to. These do not, indeed, apply to other parts of the country ; but the calculation could not otherwise be made correct, and it would not, therefore, serve as an example of the manner of making such calculations, which must be done, in the case of each farm, with a strict reference to the circumstances peculiar to that farm.

The farm is supposed to contain 500 acres, to consist partly of clay and partly of turnip-soil, and to be managed in a five years' rotation, thus:—

1st, 100 acres in corn, namely, oats.

2d, 100 acres in fallow, fallow-crops, and tares, namely,
60 acres in turnips.
30 acres in summer fallow.
5 acres in potatoes.
5 acres in tares.

100

3d, 100 acres in corn, with which are sown clover, and ryegrass seeds, namely,
60 acres in barley after turnips.
40 acres in wheat after summer fallow, potatoes, and tares.

100

4th, 100 acres in young grass, namely,
28 acres for hay and green forage.
72 acres for pasture.

100

5th, 100 acres in grass in its second year for pasture.

500 acres.

Under this system of management, the crops will succeed to one another in the order mentioned; and the farm will every year be in five divisions, namely, 100 acres in oats, 100 in fallow, turnips, potatoes, and tares; 100 in wheat and barley, 100 in young grass, and 100 in grass in its second year.

The period of entry is assumed to be on the 15th day of May with respect to the land in grass, and the land to be in summer fallow, turnips, &c.; and to the land bearing corn crops, when these are removed from the ground in autumn. This species of entry, with certain variations, prevails over *a considerable part of England. The principal of it is, that* the out-going tenant shall have a crop in the last year of his possession, or, as it is termed, a way-going crop; but that in the month of May of the same year, he shall give up to the entering tenant all the land in grass, and all the land which, in the regular course of management, would be in fallow or fallow-crops, and which the entering tenant accordingly works for his own use. The out-going tenant having sown his crop, has no further use for the houses upon the farm, and these, therefore, the entering tenant takes possession of in May.

Under this supposition, the entering tenant has no corn-crop in the first year of his possession. He reaps the first crop of corn in the second year. We may assume, that this crop is not really available to him till about the middle of November in the second year, that is, till 18 months after his entry. But the crop upon an arable farm being the chief fund of a tenant for paying his rent, and replacing his advances of all kinds, we may assume that it is not till his crop is really available, that the fund advanced by him as farming capital has been replaced. To calculate his advance of capital, therefore, we are to reckon all the charges to which he has been subjected during the first 18 months of his possession, deducting, however, any sales of produce which may have been made during that time. These advances will be conveniently divided into classes, as Implements of the Farm, Live-Stock, &c.

1. IMPLEMENTS OF THE FARM.

The first calculation to be made with respect to the implements of the farm, relates to the number of ploughs to be kept regularly at work in tilling it. Upon this depend the number of horses to be employed, and the number of ploughmen.

The manner of determining the number of ploughs or teams, is by ascertaining the extent of ground to be kept in tillage, and by assigning for this such a number of ploughs or teams as experience shows to be necessary for working the farm.

Under a perfect system of labour, one man works two horses; and this team will do all the labour required in the proportion of one pair of horses for every 50 acres kept in tillage. In the lighter class of soils, one pair of horses will work 60 acres; but it will be better to assume 50 acres as a medium. On the farm, then, to which the present calculations refer, 6 pairs of horses will require to be at work, there being in tillage each year three of the five divisions of the farm, that is, 300 acres. The number of ploughs will accordingly be 6, and that of harrows and various other implements will bear a certain proportion to this number of ploughs:—

6 Ploughs (Fig. 7) at from L.3, 10s. to L.4,—average L.3, 15s.		L.22 10 0
But ploughs may be constructed also of wood, which answer the purpose perfectly well. The expense of these will be from L.2, 16s. to L.3.		
6 Pairs of harrows made of wood (Fig. 16). at L.1, 7s.		8 2 0
1 Roller (Fig. 23), ...		12 0 0
There may be further added:		
1 Grubber (Fig. 21), . .	L.10 0 0	
2 Pairs of lighter harrows for sowing grass seeds, . . .	2 14 0	
	L.12 14 0	
But the grubber, though a highly useful, is not an absolutely necessary, implement of the farm, and need not be included in the amount of capital; and for the same reason the lighter harrows for sowing grass-seeds may be omitted.		
1 Broadcast sowing-machine (Fig. 31),		10 10 0
1 Turnip sowing-machine (Fig. 35),		6 0 0
Besides which, the nature of some farms may require,—		
1 Machine for sowing corn in rows, (Fig. 29), ...	L.10 0 0	
1 Bean-barrow (Fig. 32), or better the machine (Fig. 33), the price of which is now, .	L.1 10 0	
	L.11 10	
Carried forward,		L.59 2 0

Brought forward,				L.59	2	0
2 Hoeing-ploughs (Fig. 36),				6	0	0
2 Turnip horse-hoes (Fig. 37), with mouldboards (shown in Fig. 38),				9	0	0
1 Thrashing-machine of 6 horse power (Fig. 43),				100	0	0
This is upon the supposition that horses are employed; but should water or steam be used, there will be an increase in the first cost, although a great economy in the subsequent expense.						
1 Winnowing machine (Fig. 45),				5	10	0
1 Turnip-slicer (Fig. 47),				1	10	0
And although not absolutely necessary, there may be,—						
1 Chaff-cutter (Fig. 52),	L.7	0	0			
1 Steaming-apparatus (Fig. 53)	10	0	0			
And, though less important still,						
1 Corn bruising-machine,	7	10	0			
	L.24	10	0			
12 Single horse-carts (Fig. 51),				120	0	0
6 Sparred carts, without axle and wheels (Fig. 56),				24	0	0
1 Water-cart (Fig. 58),				9	0	0
Churn and other utensils of the dairy,				10	0	0
This may be the amount when the dairy is the affair of the household; but, where a regular dairy is established, a corresponding set of implements must be obtained.						
2 Wheelbarrows (Fig. 60),				2	0	0
1 Handbarrow (Fig. 61),				0	5	6
2 Spades (Fig. 62),				0	9	0
6 Broad-pointed lime-shovels (Fig. 63),				1	10	0
4 Narrow-pointed shovels (Fig. 64),				0	18	0
1 Mattock (Fig. 65),				0	5	0
1 Pick-axe (Fig. 66),				0	5	0
1 Foot-pick (Fig. 67),				0	7	0
1 Mall (Fig. 72),				0	2	0
1 Hammer (Fig. 71),				0	3	0
1 Sledge (Fig. 70),				0	4	6
1 Axe (Fig. 69),				0	4	6
1 Saw (Fig. 68),				0	5	0
Carried forward,				L.351	0	6

Brought forward,	L.351	0	6
6 Three-pronged forks (Fig. 73),	1	8	0
6 Small three-pronged forks for spreading dung (Fig. 74),	1	1	0
2 Dung-drags (Fig. 81),	0	6	0
2 Mud-scrapers (Fig. 82),	0	7	0
6 Forks, long (Fig. 75),	0	18	0
6 Forks, short (Fig. 76),	0	15	0
10 Wooden rakes (Fig. 78),	0	12	6
10 Turnip-hoes (Fig. 79),	0	14	2
2 Turnip-pickers (Fig. 193),	0	4	0
1 Spade for cutting turnips (Fig. 51),	0	5	0
2 Hedge-knives (Figs. 206 and 207),	0	7	0
1 Hedge-spade (Fig. 208),	0	3	0
4 Scythes, 3 long (Fig. 80), and 1 short, with straps and stones,	1	9	0
12 Sickles (Fig. 124),	0	12	0
1 Hay-knife (Fig. 83),	0	4	6
10 Weed-hooks (Fig. 123),	0	5	0
2 Throw-crooks (Fig. 133),	0	3	0
2 Long ladders of the respective lengths of 24 feet and 16 feet (Fig. 84),	2	0	0
4 Short ladders, 8 feet (Fig. 84),	1	4	0
4 Poles for laying off ridges,	0	4	0
20 Binders for cattle (Fig. 188),	1	10	0
2 Pair of sheep-shears (Fig. 195),	0	9	0
1 Stool for sheep (Fig. 197),	0	4	0
2 Sheep-racks (Fig. 194),	2	4	0
4 Straw-racks for cattle (Fig. 186),	1	12	0
1 Cane probang,	0	7	0
1 Stomach-pump, L.3 3 0			
1 Marking iron for sheep (Fig. 196),	0	2	0
10 Sheep-nets of 70 yards each,	6	0	0
200 Hardwood stakes,	0	15	0
1 Grindstone (Fig. 85),	1	0	0
1 Weighing-machine for wool and grain, with a set of weights,	2	0	0
1 Steelyard for weighing hay and straw, only necessary on certain farms, L.10 0 0			
Tubs for pickling wheat,	0	7	0
Vessel for holding grease,	0	1	0
Cart-harness for 12 horses (Fig. 59),	41	2	0
Carried forward,	L.421	16	2

	L.	s.	d.
Brought forward,	L.421	16	2
Plough-harness for do. (Fig. 14),	12	0	0
Ropes for 6 corn-carts,	1	10	0
Saddle-horse furniture,	6	4	6
1 Corn-chest,	2	10	0
1 Corn-chest for saddle-horse stable,	1	0	0
6 Currycombs for farm-horse stable, 1 Currycomb for saddle-horse stable, } (Fig. 86),	0	7	0
7 Brushes (Fig. 87),	0	14	0
7 Mane-combs (Fig. 88),	0	3	6
7 Foot-pickers (Fig. 89),	0	3	6
7 Small Forks (Fig. 77),	1	1	0
6 Pair of mouth-bags,	3	0	0
2 Stable-lanterns,	0	10	0
2 Hand lanterns,	0	4	0
1 Pair of horse-scissars (Fig. 90),	0	1	6
1 Oil-flask,	0	1	6
3 Water-pails,	0	12	0
2 Riddles for wheat,	0	5	0
2 Riddles for barley,	0	4	0
2 Riddles for oats (Fig. 140),	0	4	0
1 Slap-riddle (Fig. 139),	0	1	8
1 Sieve,	0	3	6
2 Close-sieves (Fig. 141),	0	3	0
1 Corn-measure (Fig. 142),	0	10	0
2 Wooden shovels (Fig. 143),	0	4	0
2 Brooms,	0	0	6
2 Barn-sheets,	1	0	0
100 Sacks, to contain 4 bushels each,	10	0	0
1 Load-barrow (Fig. 144),	0	10	0
4 Sparred barrows for carrying corn (Fig. 138),	5	0	0
Or the canvass-carriers, 4 at 3s. each (Fig. 137), L.0 : 12 : 0.			
Amount of Implements,	L.470	4	4

2. Live-Stock.

The farm, it has been seen, is to be managed by 6 pairs of horses, regularly employed in ploughing, and in other labours of the farm.

Besides the regular teams, there should be a spare horse.

which may be a breeding mare. The uses of a spare horse are, that by it many little operations can be performed,—as carrying water, going to market for articles required for household use or the farm, bringing home green forage and the like,—without breaking in upon the regular labours. It is necessary, too, on such a farm, that the farmer have a saddle-horse, as being indispensable for that economy of time which on every considerable farm must be studied.

The stock of horses may be therefore stated thus:—

13 Work-horses, at L.30, ...	L.390 0 0
1 Saddle-horse, ...	30 0 0
	L.420 0 0

To keep up his stock of horses, the farmer should endeavour to rear one colt every year. Now, the colt being broken in after he has completed this third year, there will be 3 colts on the farm in addition to the stock mentioned; so that the regular stock of horses upon the farm after a time will be,—

13	Farm-horses.
1	Saddle-horse.
3	Colts.
17	

The next class of live-stock consists of sheep and cattle. To determine the number and kinds of these, we must consider, 1*st*, The quantity of land which can be assigned for keeping them after the horses are supplied; and 2*d*, The mode of management which it will be expedient to pursue.

The quantity of land in grass, it has been seen, is—

Of young grass, ...	100 Acres.
Of grass in its second year, . . .	100
	200

The quantity of the young grass required for hay and forage to the horses may be thus computed:

13 Farm-horses, at 22 lb. of hay each, per day, for 5 months, ...		383 Cwt.
1 Saddle-horse, hay for 9 months at 14 lb. per day,		33¾
		416¾
Add for ewes in winter, colts, and contingencies,		177¼
		504
To produce this quantity there will be required, at the rate of 33 cwt. to the acre, ...		18 acres.
And, to soil the farm-horses, at the rate of ¾ acre each, there will be required . .	9¾ acres.	
For the saddle-horse . . .	¼	
		10
		28
The young grass in all is . . .		100
Which leaves to be depastured of the young grass		72
And there are of grass in its second year to be depastured,		100
Making of grass to be depastured in all,		172

This ground may be depastured partly with sheep, partly with cows, and partly with oxen in the course of being reared and fed. It is usual, when there is young grass upon a farm, to give it, as being the richest and most succulent, only to the ewes with lambs, and to the stock, whether of sheep or oxen, in the course of being finally fattened. But we may suppose, in the special case of the farm in question, that the whole of the spare young grass, 72 acres, is depastured by sheep; and that the whole of the older grass, 100 acres, is depastured by the cows and oxen. We have first to consider the number and kinds of sheep which 72 acres of new grass, together with such a supply of turnips as will suffice for the sheep in winter, can maintain.

Now, it is conceived that this quantity of pasture, with a proper supply of turnips, will, upon land of good quality, maintain a regular breeding stock of 120 Leicester ewes, that is, 6 scores, in the following manner.

The ewes, amounting to 120, may be expected, under a proper system of management and feeding, to produce each year, in the months of March and April, such a number of lambs as that 180 shall arrive at full maturity; and these lambs, for the sake of easier calculation, may be supposed to consist, one-half of males, and one-half of females.

In the month of July, after being weaned, these lambs receive the name of hoggets or hogs. There are, therefore, upon the farm, in each July, of sheep produced in the same year:—

90 wether-hogs.
90 ewe-hogs.

180

The ewe and wether hogs, under the system of management before explained, are to be penned together on turnips during the first winter. They will consume about 13½ acres of turnips, that is, ¾ of an acre for every 10 sheep; and if we allow 1½ acre for the ewes in the season of lambing, there will be 15 acres in all of turnips consumed by the sheep.

Now, the ewe and wether hogs are penned on turnips till the month of April, when they are turned out to the fields to pasture. In the beginning of June they are shorn, and then they receive the names,—the male sheep, of dinmonts; and the female sheep, of gimmers. The dinmonts are now to be sold, and as many of the gimmers as it is not necessary to keep upon the farm for breeding.

The regular breeding-stock upon the farm is 120 ewes; and these ewes may be supposed to be kept on the farm until they have borne each lambs for three successive years. Under this system, one-third of the ewes, that is 40, will be disposed of each year, and their place will be supplied by 40 young ewes or gimmers raised upon the farm.

Now, after shearing the sheep in June, there were 90 male sheep or dinmonts to be disposed of; and of young ewes or gimmers, there were 50 to be disposed of, the other 40 being reserved to receive the ram in October, and supply the place of the 40 old ewes.

Under this system of management, then, the ewes add, in each year, to the stock of sheep, 180, and an equal number of sheep are disposed of, namely;

90 dinmonts;
50 gimmers;
40 old ewes.

180

The sheep-stock on the 15th of May in each year, will therefore stand thus:—

120 ewes, with their lambs;
90 wether-hogs;
90 ewe-hogs.
To which add,
2 rams.

302 sheep, with 180 lambs.

These, then, are the kinds and numbers of sheep which the farmer ought to procure when he takes possession of the grass-land of his farm on the 15th of May. But it may be difficult or impossible for an entering tenant to procure at once the precise kinds of stock which he requires. All that he can do, therefore, is to make the nearest approach to it that circumstances will allow, so that he may, as soon as possible, be able to bring his stock into the regular course of management which he proposes to adopt. He may purchase at his entry,—

120 Leicester ewes, with their lambs, at 60s.,	L.360	0	0
40 Ewe-hogs, which will supply an equal number of the worst of the old ewes in the same year, at 30s.,	60	0	0
2 Shearling rams,	10	0	0
162	L.430	0	0

This, then, may be supposed to be the capital advanced for sheep-stock in the first year.

The next class of stock consists of the cows and oxen. For these there are to be assigned 100 acres of grass for pasture, and such a quantity of turnips as will maintain and feed them.

It may be assumed that there are 10 cows kept upon the farm, and that these 10 cows, besides supplying the household dairy, will rear 20 calves.

Now, the manner of management may be that formerly described as applicable to a stock of oxen. The 20 calves, in the first year, after being weaned, are pastured, and fed on turnips and straw; in the second year they are pastured, and in the second winter likewise fed on turnips and straw. They might then be killed fat; but we may suppose, so as to render the management here pointed out practicable upon every farm producing turnips, that they are pastured for a third summer, and put to fatten during their third winter, at the conclusion of which they will have completed their third year, and be, in the language of farmers, three years old. A part of these will be heifers, but it will be unnecessary to embarrass the calculation with this supposition, and therefore we may suppose them to be all males.

Under this system of management the stock of oxen, on the 15th of May in each year, will be:—

10 Cows.
20 Calves.
20 One-year-old steers, that is, steers that were calved in the preceding year, and have now completed their first year.
20 Two-year-old steers, that is, cattle that have completed their second year, and are to be fed on turnips in the following winter.
20 Three-year-old oxen, feeding on turnips, and now quite fat. But these may have been disposed of before the 15th of May.
1 Bull.

91

The number of cattle belonging to the farmer, to be pastured upon the farm in each year is,—

10 Cows.
20 Calves.
20 One-year-old steers.
20 Two-year-old steers.
1 Bull.

And this, therefore, is the stock to be purchased on the 15th of May in the year of entry. It may not, perhaps, be practicable to get the precise kinds of stock required in the first year, but a near approach to it may generally be made. It may, therefore, be supposed that the capital advanced in the first year for this class of stock is, for—

10 Cows, calved, and which have received the male,	L.120	0	0
20 Calves, ...	30	0	0
20 One-year-old steers, at L.7, 10s., .	150	0	0
20 Two-year-old steers, at L.12, 10s., . .	250	0	0
1 Bull, one-year old, ...	15	0	0
71	L.565	0	0

Here is to be noticed a matter of entirely local usage with respect to the manner of paying the regular servants of the farm. They are paid partly in money, but chiefly in produce; and one of the articles of produce is food, winter and summer, for a cow. Each cottager, then, keeps his cow, an admirable arrangement, conducive in an eminent degree to the physical comforts of the labourer, and deserving of universal imitation in the British Islands. We shall see, in the sequel, that there are 9 regular cottagers upon the farm. Besides the pasture required for the 71 animals before enumerated, therefore, there must be a sufficient quantity for the 9 cows, the property of the cottagers, that is, for 80 cows and oxen in all.

The quantity of grass-land to be depastured is 100 acres, which will suffice, if the land be of good quality, to pasture the quantity of cows and oxen mentioned. But they will also require the following quantities of turnips :—

20 Calves will require ¼ acre each, . .	5 acres.
20 One-year-old steers, ¾ acre each, . .	15
20 Two-year-old steers put to fatten, 1 acre each, .	20
19 Cows, including those of the cottagers, about ¼ acre each,	4½
1 Bull, ...	½
80	45

If to this be added the 15 acres required by the sheep stock, it will be seen that the division of the farm which is to be in turnips every year will suffice for keeping and feeding the stock.

The next class of live-stock is attended with no difficulty, namely, the swine. These will soon breed up to the quantity required. At the entry in May, there may be purchased,—

2. Breeding sows, at L.2,	L.4	0	0
1. Young boar,	1	0	0
	L.5	0	0

The remaining class of live-stock consists of poultry. This, like the last, will quickly breed up to the numbers wished for, In the first year may be purchased,—

20 Chickens,	L.1	10	0
12 Ducks,	0	18	0
3 Geese,	0	12	0
3 Turkeys,	0	15	0
	L.3	15	0

The capital, therefore, advanced for the different classes of live-stock will be as under:—

1. Horses,	L.420	0	0
2. Sheep,	430	0	0
3. Cattle	565	0	0
4. Swine,	5	0	0
5. Poultry,	3	15	0
	L.1423	15	0

3. Seeds.

Previous to the period when the farmer takes possession in May, there ought to have been sown the grass and clover seeds on the division of the farm which, in the regular course, is to be sown with them. The out-going tenant, however, has no interest in sowing these seeds, of which he does not reap the benefit; but the entering tenant either sows them, or pays the cost of them to his predecessor. Now, supposing the same rotation to have been hitherto adopted as is now to be adopted, there will be a division of 100 acres to be sown with grass seeds, namely, that which is in wheat and barley.

100 acres sown with perennial ryegrass seeds, at 1 bushel per acre, and 3s. per bushel,	L.15 0 0	
Clover seeds, 10 lb. per acre, at 10d. per lb.	41 13 4	
		L.56 13 4
And in the second spring there will be an equal quantity to be sown,		56 13 4

Tares to be sown in the first year for horses and pigs :—

5 acres, at 3 bushels per acre, = 15 bushels at 5s. per bushel,	L.3 15 0	
A similar quantity in the second year,	3 15 0	
		7 10 0

Arrangements too should be made in the first year to plant potatoes ; and here it is to be observed, that, by the practice before referred to of paying the labourers in kind, each cottager is allowed to plant a quantity of potatoes, equal to about ¼ acre. The farmer himself may plant,—

1¾ acres for household use, at 24 bushels per acre, at 1s. 4d. per bushel,	L.2 16 0	
1 acre for pigs,	1 12 0	
2¼ acres for cottagers,	0 0 0	
5 acres		4 8 0

The further seeds to be sown in the year of entry are—

60 acres turnips, at 2 lb. per acre, = 120 lb. at 9d. per lb..	L.4 10 0	
The same quantity in the following year,	4 10 0	
		9 0 0

There is no corn to be sown in the spring of the year of entry ; but in the autumn of the same year, the division of the land in summer-fallow, namely, 40 acres, is to be sown :—

40 acres of wheat, at 3 bushels per acre, = 120 bushels 6s. 8d. per bushel,		40 0 0
Carried forward,		L.174 4 8

Brought forward,	L.174 4 8

In the spring of the second year are to be sown the oats and barley, namely,—

100 acres of oats, at 5 bushels per acre, = 500 bushels at 2s. 8d. per bushel,	66 13 4
60 acres of barley, at 3 bushels per acre, = 180 bushels at 3s. 8d. per bushel,	33 0 0
	L.273 18 0

4. MANURES.

The dung made in the preceding winter has not at the period of entry been applied to the land, because the land to be in turnips and summer-fallow, to which, in the regular course, it would be applied, are not yet ready to receive it. In the practice of the district in question, there is an almost general stipulation in the leases that this dung shall be given to the entering tenant, who either receives it free of charge, or pays his predecessor the value.

Making this latter assumption, the quantity of dung may be supposed to be 1000 tons, which, at 6s. 3d. per ton,	L.312 10 0

A tenant does not always lime his land in the first year of his possession, and yet it is often very important that he should do so. Let it be supposed that he limes 40 acres in the summer of the first year, and an equal quantity in the summer of the second year.

80 acres, at 144 bushels per acre, = 11520 bushels at 8d. per bushel, prime cost,	L.144 0 0	
Tolls and other charges, the distance being supposed 12 miles, at the rate of 1¼d. per bushel,	60 0 0	
		204 0 0
		L.516 10 0

5. Labour.

The farm-servants, it has been said, are paid partly in produce and partly in money. The cost to the farmer may be computed thus, though the value to the receiver is considerably more:—

Money,		L.2 10 0
60 bushels of oats, at 2s. 8d.		8 0 0
18 bushels of barley, at 3s. 8d.		3 6 0
6 bushels of pease, at 4s.		1 4 0
Food in harvest,		1 5 0
Allowances in travelling, &c.		0 10 0
	Outlay,	L.16 15 0
Grass and winter food for a cow,	L.6 0 0	
Carriage of coals, 4 cart-loads,	1 10 0	
Ground for potatoes, 1000 yards of a drill,—about ¼ acre,	0 10 0	
		8 0 0
		L.24 15 0

Besides a house, a small garden, permission to keep a pig, fowls, &c.

Applying this calculation to the wages of the ploughmen and other cottagers, the outlay in money to them and the other labourers will be:—

6 Ploughmen, at L.16, 15s. per annum for 18 months,	L.150 15 0
1 Principal servant or overseer, L.5 per annum more than the others for 18 months,	32 12 6
1 Shepherd, wages the same as the overseer,	32 12 6
1 Hedger, employed chiefly in hedger-work, but also in other work upon the farm,	25 2 6
1 Man to take care of the cattle in winter, and do any common work in summer, at 10s. per week for 18 months, not a cottager,	39 0 0
Females and young persons are employed in hoeing turnips and other work. Their wages for 18 months may be,	60 0 0
Carried forward,	L.340 2 6

Brought forward,				L.340	2	6

The entering tenant takes possession of the land to be worked for fallow and fallow crops in May. But, previous to this time, it ought to have received at least one ploughing, for which the entering tenant pays those who have laboured it:—

100 acres fallow, at 7s. per acre, . .				35	0	0

The other items of outlay on labour are :—

Mowing hay, 18 acres, at 2s. 6d. .	L.2	5	0			
The same the second year, .	2	5	0			
				4	10	0
Expense of the harvest work in the second year, that is, for the first crop raised by the new tenant,				87	0	0
Keeping up the iron-work of horses and implements, at the rate of L.3 per pair of horses,—1½ year, L.27.						
But the implements being new, the half of this will suffice for the first 18 months,				13	10	0
Carpenter-work, on the same principle, . .				13	10	0
Additional blacksmith and carpenter-work, .				5	0	0
Saddler's-work, at the rate of L.1 per pair of horses for 1½ year, ...				9	0	0
Shoeing saddle-horse for 1½ year, . .				1	10	0
Keeping houses in repair for 1½ year, L.7, 10s. One-half for the first 18 months, . .				3	15	0
Incidental expenses, drugs to live-stock, oil for lamps, candles, tolls, expenses of marketing, &c. .				16	0	0
				L.528	17	6

6. Maintenance of Horses.

The annual expense of a working-horse, according to the method of keeping horses formerly described, may be calculated thus :—

Oats, 91¼ bushels, at 2s. 8d. per bushel, . .	L.12	3	4
Green forage, ¾ of an acre, at L.6, . . .	4	10	0
Hay for 5 months, at from 20 lb. to 22 lb. per day, say 22 lb. = 29½ cwt. at 3s. 6d. per cwt. .	5	3	3
Tares, ¼ acre at L.6, .	1	10	0
	L.23	6	7

The outlay on feeding horses, for the first 18 months, may be calculated as under :—

Hay for three weeks after entry for 13 horses, at 22 lb. per day, = 53½ cwt. at 3s. 6d. per cwt. .	L.9	7	3
Hay for saddle-horse after entry, 4 cwt. at 3s. 6d.	0	14	0
Oats for 13 horses for the first year, at 91¼ bushels each, = 1186¼ bushels at 2s. 8d. . .	158	3	4
Oats for 4½ months in the second year, until the crop can be made available, = 438¾ bushels, at 2s. 8d. per bushel, ...	58	10	0
Oats for saddle-horse for 1 year and 4½ months, = 125 bushels, at 2s. 8d.	16	13	4
	L.243	7	11

7. BURDENS.

Window and saddle-horse duty, ...	L.2	15	9
Statute-labour, 1 year, ...	5	0	0
Poor-rates, ...	15	0	0
Insurance, 2 years, ...	9	0	0
	L.31	15	9

ABSTRACT.

The various items of capital enumerated are as follows :—

1. Implements, ...	L.470	4	4
2. Live-stock, ...	1423	15	0
3. Seeds, ...	273	13	0
4. Manures, ...	516	10	0
5. Labour, &c.	528	17	6
6. Maintenance of horses, ...	243	7	11
7. Burdens, ...	31	15	9
	L.3488	8	6

To this sum should be added the expense of furnishing a dwelling-house, .	L.200	0	0			
Family expenses for 1½ year, .	150	0	0			
				350	0	0
Amount of outlay,				L.3838	8	6

PRODUCE SOLD.

Those parts of the produce of the farm sold during the first 18 months, and which must be taken into account, are :—

20 Two-year old cattle, which, after being wintered on turnips, may be reasonably supposed to weigh 65 stones, at 6s. per stone,			L.390 0 0
40 old ewes, at 40s.		L.80 0 0	
The same for the second year,		80 0 0	
			160 0 0
50 Gimmers at 27s.			67 10 0
90 Dinmonts, at 32s.			144 0 0
50 Pigs, which may be reared each year to 7 stones each, at 3s. 6d. per stone,		L.61 5 0	
One-half year more,		30 12 6	
		L.91 17 6	
But during the first 18 months the calculation may be one-half,			45 18 9
Produce of dairy, which, besides rearing calves, may be supposed to be at the rate of 35s. per cow per annum—1½ year,			26 5 0
There will be 162 fleeces of wool sold the first season, viz.—			
120 Ewes, at 6½ lb. each,		780 lb.	
40 Ewe-hogs, at 7½ lb. each,		300	
2 Young rams, at 8 lb. each,		16	
		1096 lb.	
There will be 302 fleeces the second year, viz.			
120 Ewes, at 6½ lb. each,	780 lb.		
180 Ewe and wether hogs, at 7½ lb.	1350		
2 Rams, at 9 lb.	18		
		2148	
		3244 lb.	
3244 lb. of wool, at 1s. per lb.			162 4 0
Amount of produce sold,			L.995 15 9

Amount of outlay during the first 18 months,	L.3838	8	6
Produce sold,	995	17	9
Net Capital,	L.2842	10	9

The net capital required for a farm of 500 acres is thus at the rate of L.5 : 13 : 8½ per acre. But the calculation is made on the supposition that no rent is paid until the crop is reaped. If the rent shall be paid before the crop is made available to the tenant, there will be an addition, equal to the rent, to the sum to be advanced.

IV. EXPENSES AND PRODUCE OF THE FARM.

The capital necessary for a farm is the fund which ought to be available to the possessor, that he may carry on his business : the annual expenses of a farm are the necessary charges to which a farm is subject. A very convenient period for determining the annual expenses of a farm is from May to May, but it may be done also from November to November, or indeed from any one period in the year to the same period in the following one, so as to comprehend the charges of the entire year.

To calculate the average charges of a farm, the same data are assumed as in calculating the capital, namely, that the farm consists of 500 acres, and that it is managed, with respect to rotation of crops and the number and disposition of live-stock, in the manner already explained.

The first consideration, and a large charge in the calculation of farm expenses, is Rent. Ingenious reasonings have been employed to show, that rent is necessary to equalize the profits of land of different degrees of fertility ; that, in every country, it is a charge as necessary as the wages of labour : but here we have only to consider the fact, that rent is a charge upon all who farm the lands of others in this country.

The amount of rent should be such as to leave to the occupier a sufficient interest upon the capital advanced by him. This will in some degree depend upon the general rate of interest in the country, so that, *cæteris paribus*, rent should rise as the rate of interest falls. Thus, supposing that, when money is at 4 per cent., the farmer required 16 per cent. on his capital, when the general rate of interest has fallen to 3 per cent., he should receive 12 per cent. The advances of the farmer have been calculated at L.2842 : 10 : 9, and there being deducted L.350 for family expenses and the furnishing of a dwelling-house, the capital upon which interest should be charged is L.2492 : 10 : 9, upon which sum 16 per cent. is L.398 : 16 : 1. Taking this as the farmer's return, and assuming certain rates of farm produce after mentioned, the rent of the farm to which these calculations refer will be L.985 : 11 : 4.

1. *EXPENSES.*

The various kinds of outlay in money on a farm may generally be classed under five heads:—1. Rent and burdens; 2. Stock purchased; 3. Seeds purchased; 4. Manures; 5. Labour and minor outlays.

The amount of these is the outlay in money. The wages of the labourers indeed may be paid in produce, or partly in produce and partly in money; but it is better, in calculating the outlays upon a farm, to consider the wages of the labourers as a payment in money. What is consumed upon the farm, the produce of the farm itself, as seeds, corn and hay for horses, turnips, and the like, ought not to be regarded as an outlay, but as a diminution of the produce of the farm. When the outlay in money is known, the farmer has merely to deduct this from the produce of the farm which he can bring to market, to ascertain his profit. The following calculations, then, show the annual expenses of the farm, including the wages of the labourers, in money; and it is to be kept in mind, that these calculations are, as in the case of those regarding capital, nothing more than an example, and that they have an especial reference to local usages, and to a condition of the farmer which applies only to a given district.

1. Rent and Burdens.

Rent,		L.985 11 4
Burdens, viz.,		
Window and saddle-horse duty,	L.2 15 9	
Statute-labour,	5 0 0	
Poor-rates,	10 0 0	
Insurance,	4 10 0	
		22 5 9
		L.1007 17 1

2. Stock Purchased.

10 Calves, at 30s.	L.15 0 0

3. Seeds Purchased.

60 acres turnips at 2 lb. per acre, = 120 lb., at 9d.,	L.4 10 0
5 acres tares, at 3 bushels per acre, = 15 bushels at 5s.,	3 15 0
100 acres ryegrass seeds, at 1 bushel per acre, = 100 bushels, at 3s.,	15 0 0
100 acres clover-seeds, at 10 lb. per acre, = 1000 lb., at 10d.,	41 13 4
	L.64 18 4

4. Manures.

It may be assumed that the whole land is limed once during the first 10 years of the lease, at the rate of 50 acres annually: 500 acres at 144 bushels per acre = 72,000 bushels, at 4¼d. per bushel, = L.1275. This, for 20 years, supposing 20 years to be the duration of the lease, will be, per annum,	L.63 15 0
And further, there may be supposed to be laid out annually, for foreign manures, as bone-dust, rape-dust, &c.	25 0 0
	L.88 15 0

4. LABOUR, &c.

6 Ploughmen, wages as before, L.16, 15s. each,	L.100	10	0
1 Overseer,	21	15	0
1 Shepherd,	21	15	0
1 Hedger,	16	15	0
1 Person to take care of cattle, &c., at 10s. per week,	26	0	0
Hoeing, haymaking, &c.	40	0	0
Mowing hay, 18 acres at 2s. 6d.,	2	5	0
Harvest Work, 200 acres,	87	0	0
Carpenter's work for implements, at the rate of L.3 per pair of horses,	18	0	0
Iron-work for implements, at the same rate,	18	0	0
Saddler's work, at the rate of L.1 per pair of horses,	6	0	0
Shoeing saddle-horse,	1	0	0
Additional iron and carpenter work, not included in the above,	7	0	0
Keeping houses in repair,	5	0	0
Expenses of carrying grain to market, supposing the distance to be 12 miles, carrying fuel to servants, marketing and delivery of stock, farriery, and minor charges,	32	16	6
	L.403	16	6

ABSTRACT.

1. Rent and burdens,	L.1007	17	1
2. Stock purchased,	15	0	0
3. Seeds purchased,	64	18	4
4. Manures,	88	15	0
5. Labour, &c.	403	16	6
	L.1580	6	11

II. *PRODUCE.*

There remains to be considered what, on this calculation of expenses, may be the annual return of such a farm. This may be comprehended under two divisions—Vegetable Produce, and Live Stock.

1. VEGETABLE PRODUCE.

		Bushels.			
100 acres of oats, at 48 bushels per acre,		4800			
The quantity consumed upon the farm is—					
For seed, ...	500 bush.				
For work-horses, ...	1186¼				
For saddle-horse, . .	91¼				
For colts, hogs, and poultry, . .	60				
		1837½			
Leaving for sale,		2962½			
2962½ Bushels, at 2s. 8d., . . .			L.395	0	0
40 acres of wheat, at 24 bushels per acre,	960 bush.				
Deduct for seed, 3 bushels per acre,	120				
840 Bushels, at 6s. 8d., . . .			280	0	0
60 acres of barley, at 42 bushels per acre,	2520 bush.				
Deduct for seed, 3 bushels per acre,	180				
2340 Bushels, at 3s. 8d., . . .			429	0	0
Net annual return of Vegetable Produce,			L.1104	0	0

2. LIVE-STOCK.

The sale of horses upon some farms is a source of profit; on a regular farm, however, it will be safer not to calculate upon the profit derived from the breeding of horses, but rather to suppose that the horses reared are just sufficient to repair the casualties, and replace the tear and wear of the original stock.

The produce of the dairy, after rearing 20 calves, may be calculated at 35s. per cow, or	L.17	10	0
50 Pigs may be supposed to be sold or used each year, fed to 7 stones, at 3s. 6d. per stone, . .	61	5	0
Poultry, ...	7	10	0
20 Three-year-old steers, after being wintered on turnips, supposed to weigh 65 stones each, at 6s. per stone, ...	390	0	0
40 Old Ewes, at 40s.	80	0	0
Carried forward, .	L.556	5	0

Brought forward,	L.556	5	0
50 Gimmers, at 27s.,	67	10	0
90 Dinmonts, at 32s.,	144	0	0
Wool, 2148 lb., at 1s.,	107	8	0
Net annual return of Live-stock,	L.875	3	0

ABSTRACT.

Vegetable produce,	L.1104	0	0
Live-stock,	875	3	0
	L.1979	3	0

If, from the gross produce as above,	L.1979	3	0
Be deducted the expenditure in money,	1580	6	11
The net return to the farmer will be,	L.398	16	1

Out of this sum the farmer must maintain himself, and bear the hazard of bad debts, unforeseen losses, and the general casualties of trade. Should the produce be less, or the capital or expenses greater, the amount of rent will be in a corresponding degree diminished.

V. OPERATIONS OF THE FARM IN THE ORDER OF TIME.

The operations of the farm, connected with tillage and the management of live-stock, have been described; but we have yet to consider these operations in the order of time in which they succeed to one another. This review will tend to render more precise a previous knowledge of details, and to obviate that perplexity which is often experienced by those who are brought to the study of practice for the first time, and see so many different labours carried on together, and without apparent order. It will here suffice to detail the most important of these labours, as they occur in a well-ordered farm, employed partly in tillage, and partly in the rearing and feeding of live-stock, and managed according to the system of agriculture which has been especially described in this work.

NOVEMBER.

The month of November may be said to be the commencement of the farmer's year. By this time the labours of his harvest have been concluded, and his produce has been secured; and he is now proceeding to prepare the ground for the crop of another season. There are to be considered the state of the farm at the commencement of this month with respect to labour and live-stock, and the principal operations during its continuance.

Live-stock.—The cattle may be supposed to consist of cows; of a certain number of calves; of a certain number of the steers and heifers of the preceding year, termed therefore one-year-olds, as having completed their first year, but now approaching to the end of their second year; of a certain number of steers and heifers which have completed their second year, and are therefore termed two-year-olds, though now approaching the end of their third year: and of a bull. The two-year-old steers and heifers are now arrived at maturity; the heifers intended for breeding have received the male in the course of the season, and the older steers are ready for final feeding.

As the month of October had advanced the pasture had begun to fail, and before the termination of the month the various cattle had been put in their respective houses, yards, and stalls.

The cows which had borne calves in the early part of the year, had been put in the cow-house and tied in their respective stalls,—straw, and a limited proportion of succulent food, as turnips, having been supplied to them.

The calves which were born in the early part of the year, had been put in one or more yards with sheds, had been well littered, and had received straw as their provender, with a full allowance of turnips.

The steers and heifers of the preceding year, now turned their first year, and approaching the end of their second year, had also been put into yards with sheds. They had likewise been plentifully littered, receiving straw as provender, with a full allowance of turnips.

The older cattle, namely, those that have completed their second year, had been treated thus:—Such of them as were heifers to be retained for breeding, had been separated from the males in the preceding spring, had received the male as they came into season in spring and the early part of summer, and, being with calf, had been put into yards with sheds, to be tied to their respective stalls, when within a few weeks of calving. The steers again, which are now to be finally fattened, had either been tied in stalls, or put in pairs into yards with sheds, in either case receiving a full allowance of turnips or other nourishing food.

The bull had been put into a shed or yard by himself, receiving straw for provender, and a sufficient supply of turnips.

Such may be supposed to be the arrangement of the cattle at the commencement of the month of November. The same treatment with respect to them is to be continued during the entire month:—The cows and heifers are to receive straw, with a modified allowance of turnips: the calves and steers straw, with a full allowance of turnips.

The sheep again, consisting, it may be assumed, of a regular breeding stock of ewes, may be supposed to have been arranged and treated thus:—The ewes, consisting partly of sheep that had borne lambs, had, by the 10th of October, the rams admitted to them. At the beginning of November, the rams and ewes are still pasturing together, receiving no other food but grass; and by the middle of the month the rams are withdrawn.

The lambs born in spring, now termed ewe and wether hogs, had, on the failure of the pastures in October, been penned on turnips. At the beginning of November they continued penned on turnips, the province of the shepherd being to attend to them as well as to the other sheep, and to shift the pens when necessary.

The horses in the month of October had been put upon their full allowance of hay and corn. At the beginning of November they are receiving full feeding, but before the middle of the month, when the hours of labour become short, the hay may be withdrawn, and the allowance of oats reduced to the half of the former quantity.

By the beginning of the month the colts had been put into their yards or into a paddock with a shed, receiving straw as provender, with any succulent roots, as turnips and potatoes.

The swine and poultry are receiving their usual food. The pigs are fattened at all times; and the poultry receive their regular supplies of food in their yard: and as the same method of management continues throughout the year, the feeding of this class of stock need not be again adverted to.

Labour.—As soon as the season of harvest was over, and the crop secured, the operation had been begun of ploughing the stubble-land—that is, the land which, having borne a crop of corn, is intended to be in summer-fallow, or fallow-crops as turnips and potatoes, in the following year. At the beginning of November, then, the stubble-land is being ploughed, and this operation is continued throughout the month, the horses being kept regularly employed at this work, unless interrupted by frost or snow, or otherwise necessarily engaged.

The thrashing of the crop is now carried on, so as to supply straw for litter and provender in a regular manner to the cattle. The corn is prepared and carried to market, that being retained which is required for feeding the stock upon the farm.

At the commencement of and during the month, turnips are carried home in carts to the stock in the houses and yards, every two or three alternate drills being taken up for the cattle, while the remainder is left in the ground for the sheep which are penned in the field.

This is the fitting season for pruning hedges, cleaning ditches, and performing other operations upon the live-fence. Hedger and ditcher work are, therefore, carried on during all the month of November, and draining and any kind of work by the spade. The work of the hedger is continued in winter when the weather allows, in spring, in the early part of summer, and in autumn; and draining and other spade-work are carried on at every convenient season. These labours of the farm therefore need not be afterwards referred to.

Winter being now at hand, it will be prudent to secure a supply of fuel, which the horses may be employed to bring home when they are not otherwise occupied.

These, then, have been the principal labours of the farm during the month of November, which may be said to be the first month of the winter quarter:—The cattle and sheep of all kinds have been receiving their winter food; the horses, from a full allowance of hay and corn, have been put upon straw and a smaller allowance of corn; the operation of thrashing has been carried on; the horses have been chiefly employed in ploughing the stubble-land for the fallow-crops and summer-fallow of the next year; the hedger has been engaged in pruning and repairing the hedges, and spade-work when required has been going on; and a supply of fuel has been provided against approaching winter.

DECEMBER.

Live-stock.—The cows are in the cow-houses; the young cattle in their yards; the feeding cattle in their houses or yards as before; and they are all kept and treated in the same manner throughout the month.

The ewes are, as before, on grass, but in snows or hard frosts they receive an allowance of hay. The ewe and wether hogs are penned on turnips as before, and are kept so during the month.

The hours of daylight and consequently of labour, being short, the horses are still fed on straw, and receive their modified allowance of corn. The colts are in their yard or paddock receiving straw, with an allowance of green food, and are kept so during the month.

Labour.—The ploughing of the stubble-land continues during this month when the weather allows; and, in ordinary circumstances, it may be calculated that all the land intended for fallow and fallow-crops has been ploughed before the termination of the month.

Thrashing is continued throughout the month so as to supply the stock regularly with straw, and the grain is carried to market in proportion as it is got ready. The wheat and barley-straw is used chiefly for litter, and the grain is sold. The oat-straw is used for fodder; but instead of all the oats being sold, a portion of them may now be stored in the granary for the purpose of being used for seed in Spring. This too is the time of delivering the grain to the servants, when the practice of paying them in kind is followed.

A quantity of turnips should be pulled to be ready for the cattle in case of frost and snow. A portion should be placed either in a store in the open air, or, which is better, under a shed. Those given to the older feeding stock should be cut by the turnip-slicer.

Towards the end of the month, should the weather not admit of ploughing, the carts are to be employed in carrying out dung from the yards, to be piled in heaps in the fields in which the turnips and other fallow-crops are to be grown in the following year.

During the month of December, then, the stock of all kinds have been on their winter food; the horses have been on short day's work, and on their winter allowance of corn and straw; they have been employed in ploughing the remainder of the stubble-land, in bringing home turnips to the stock, in carrying corn to market, and towards the end of the month in taking out dung from the farm-yards.

December may be said to be the dead season of the farmer's labour, and yet it is not without its objects of interest and solicitude. The farmer is engaged in realizing his profits; his animals of different kinds are feeding under his care; and he is soon to look to the more active labours of spring.

JANUARY.

Live-stock.—The cattle are still in their houses and yards, and are fed as during the last month: turnips being brought home and a store kept in reserve as formerly. Some of the cows may calve during this month, especially towards the end of it. They are to be well attended to at this time; and the calves separated from them at the birth and fed on new milk three times in the day.

The ewes are on grass-land, receiving hay when the weather renders it necessary. The ewe and wether hogs continue penned on turnips as during the previous month.

The horses are on straw, and are receiving their short allowance of corn. The colts are in their yard or paddock, and are fed as before.

Labour.—The stubble-land intended for fallow and fallow-crops may be supposed to have been ploughed by the end of the last month. The land in grass intended to be sown with oats in spring, may now therefore be begun to be ploughed, and the horses kept engaged in this operation when the weather allows, and when they are not otherwise necessarily engaged.

Corn is to be thrashed to furnish straw for provender and litter, as during the preceding month. Wheat and barley are to be sent to market as usual, and the storing of oats for seed may be continued.

Turnips are brought home to the cattle in the houses and yards as formerly; and dung, when the weather will not admit of ploughing, is carried out from the yards.

These, then, have been the principal operations in the month of January:—The cattle have been fed on straw and turnips as in the former month; the ewes have been kept on grass receiving hay during hard frost and snow; the ewe and wether hogs have been penned on turnips as before; the horses have been kept on straw and their short allowance of corn; the thrashing of the corn has been proceeding; the grass-land intended for oats has been ploughed as the weather has allowed; and the dung has been carried out of the yards.

FEBRUARY.

Live-stock.—The cattle are in their houses and yards, and are fed as during the last month. The cows will calve during this month, and must be carefully attended to.

The ewes are on grass; but after the middle of the month they should have turnips carried to them in the fields in which they are pasturing, so as to prepare them for the lambing season by the middle of next month. The ewe and wether hogs are penned on turnips as before.

By the middle of the month, if not sooner, the horses should be put again upon hay, and receive their full allowance of corn, in preparation for their work in spring. In place of straw, the colts may now receive hay.

Labour.—The ploughing of grass-land intended for oats proceeds during the month, and it is usual that the land which is to be first sown shall be first in the order of being ploughed.

Corn as before is thrashed, so as to afford straw regularly for provender and litter. The corn which is still for sale is carried to market; the oats which it is yet necessary to reserve for seed are stored. Barley, too, may now be stored, in preparation for the sowing of barley in April.

The land from which turnips has been cleared is now to be formed into ridges; and in frosty weather, when the ploughs cannot work, the dung is to be carried from the yards to the fields as formerly.

If spring-wheat is to be sown upon the land that has been in turnips, it may be done when the land is dry and the weather favourable; and should there be beans to be sown, the land may be worked and the beans sown when the ground is dry.

The following, then, have been the principal operations in the month of February:—The cattle have been kept in their houses and yards, feeding as formerly; the cows have been attended to when calving; the young sheep have been on turnips, and the ewes have received turnips after the middle of the month; the horses have been put on their full work, and have received their full allowance of food; corn has been thrashed in proportion as the stock has required straw for provender and litter; the grain has been sold, or stored for seed; the land in grass has been ploughed for oats; the cleared turnip-land has been formed into ridges, and where spring wheat was to be sown, that has been done; if the weather has allowed, the land intended for beans has been worked, and the beans have been sown; and in frosty weather dung has been carried out from the yards.

MARCH.

Live-Stock.—The cattle are still in their yards, and feeding as before. During the month all the cows may be supposed to have calved. The additional calves required are to be purchased, the best and earliest that can be obtained.

The ewe and wether hogs are on turnips as before. The ewes will now begin to lamb. They have been hitherto receiving turnips, but as they lamb they are transferred with their young to new grass. The male lambs are castrated in lots when about eight days old.

The horses are on full work, and are receiving their full allowance of hay and corn. The colts are receiving hay.

Labour.—The corn is thrashed throughout the month to supply straw. The grain is sold, except such of the oats or barley as are required for seed, or the purposes of the farm.

If any of the grass-land intended for oats has not yet been ploughed, it must now be done, and any turnip-land cleared of turnips, and not yet ploughed, must now be ploughed.

The oats are now to be sown as soon in the month as the land is sufficiently dry; the late ripening sorts being the first in the order of sowing, and next the more early.

Tares are to be sown in portions, at intervals of ten days or a fortnight, so that they may be ready in succession in summer and autumn. The land intended for potatoes may now be cross-ploughed. Towards the end of the month, if the weather and state of the ground allow, the grass and clover seeds may be sown amongst the growing wheat. The land is to be harrowed, and it may at the same time be rolled; but the rolling may be delayed until the month of April. The dung intended for the early-sown turnips should now be turned over, to hasten the putrefactive process.

These, then, have been the principal operations of the month of March:—The cattle have been fed on straw and turnips as before; the calves have been fed on new milk; the young sheep have been fed on turnips; the ewes, after lambing, have been transferred with their young to new grass; the horses have been fully worked and fed; the corn has been thrashed, and barley stored for seed; any remainder of the grass-land not yet ploughed has been ploughed, and also any land cleared of turnips; oats have been sown, and tares in portions at intervals; grass and clover seeds, if the weather has been favourable, have been sown amongst the growing wheat; and the dung for early turnips has been turned.

APRIL.

Live-stock.—The cattle are still in their yards, and are fed as before; the calves are receiving milk, with such nourishing substances in addition as may enable the milk of each cow to bring up two calves.

The ewes are now on new grass with their lambs. At the commencement of the month, the ewe and wether hogs are still on turnips, but by the middle of the month they are removed from turnips and put on grass.

The horses are at full work, and receive a full allowance of hay and corn. The colts that have reached their third year may now be taken up and trained to work; or they may be allowed another summer's grass, and be taken up for training in autumn. Mares will foal during this month.

Labour.—If any part of the oats had not been sown during the preceding month, they are now to be sown; if the grass and clover seeds had not been sown amongst the growing wheat, they are now to be sown.

The potato-land which had been cross-ploughed in the preceding month, is to be ploughed again, harrowed, and otherwise worked, and the potatoes are to be planted.

The land which had been for some time cleared of turnips and ploughed, receives a second ploughing or a seed-furrow; that which is just cleared may receive only one ploughing. The barley is sown, the grass and clover seeds are sown and harrowed, and the land is rolled. If the wheat-land had not been rolled at the time of sowing the grass-seeds, it is now rolled.

The land in new grass, and intended to be mown, is to have the stones upon the surface gathered, and to be rolled.

The barley being sown, and that as early in the month as possible, the preparation of the land for turnips commences; but it is proper that the land intended for summer-fallow should also at this time receive one ploughing, so as to keep down the growth of weeds, and facilitate the subsequent preparation of the ground; therefore the whole land intended for summer-fallow and turnips is now to be ploughed,—the land intended for turnips in the first place, and across: the land intended for summer-fallow lengthwise, so as to preserve the former ridges.

In preparing the land for turnips, that intended for the early-sown kinds is to be first worked, and care must be taken that the dung to be applied be in a proper state of preparation. If the dung is not so, the heap must be turned a second time; and the heaps intended for the later-sown turnips must also be turned.

The cattle being in their yards during the whole of this month, the thrashing of corn, so as to yield straw for provender and litter, has been proceeding as hitherto.

These, then, have been the principal operations in the month of April:—The cattle have been fed in their yards with straw and turnips; the calves have been receiving milk; the ewes and lambs have been fed on new grass, and the ewe and wether hogs, after having been fed on turnips till about the middle of the month, have been put also on grass; oats have been sown, if they have not already been sown; the potato land has been planted; the land cleared of turnips has been ploughed, and the barley and the grass and clover seeds have been sown; all the land which it is necessary to roll has been rolled, namely, the barley-land, the new grass-land intended for mowing, and the wheat-land which had not been previously rolled; the land intended for turnips and summer-fallow has been ploughed, and the heaps of dung for turnips have been turned; and corn has been thrashed in the quantity necessary to furnish straw for the live-stock.

MAY.

Live-stock.—At the commencement of the month, the cattle are in their yards and are fed as before.

By the middle of the month, the former year's calves, now yearling steers, and the two-year old steers, if the grass is sufficiently advanced, are turned out to pasture; the cows are turned out to pasture; and here it may be observed that if there are any of the two-year-old cattle which are heifers from which it is wished to breed, they must be separated from the steers of the same age and placed amongst the cows, and when they come into season, if they have not already done so, they must receive the male. During this month the older cows should all have received the male, so that they may calve in the following February.

With respect to the feeding oxen now turned their third year, and consequently three-year-olds, these may be fed during the month as long as there are turnips sufficient for them, and then sold.

During this month the mares should all have received the male, so that they may foal in the subsequent month of April. The colts are turned out for the season to grass.

As the weather becomes warm, the sucking calves may be turned out to a small paddock. After being weaned in their fourth month, they are turned out to feed for the remainder of the season, along with the cows and feeding-stock.

The sheep of all kinds at the commencement of the month were on grass, and they continue to be pastured in their respective fields during the month. By the end of it, the fat sheep, if ready, may be washed and shorn, or else these operations are deferred till the beginning of June.

The horses are in their stables and receive their full allowance of hay and corn.

Labour.—Should any of the barley not have been sown during the last month, it must now, together with the grass seeds, be sown; and if the stones have not been gathered from the new grass, this must be done.

The land planted with potatoes is to have the drills levelled by the harrows passing over them. But the main labour of this month is the preparation of the land for turnips, which is to be done for the different kinds of turnips respectively, in the order in which they are to be sown; the first in the order of sowing being the Swedish turnips, the second the yellow turnips, and the third the white.

The land then intended for Swedish turnips, which had been cross-ploughed in the preceding month, is to be again ploughed, harrowed, rolled, cleaned, and made ready for being formed into drills; and the dung being applied, the seeds are sown.

The working of the other turnip-land is then to be proceeded with, so that it may be ready for being sown at the beginning of June. This land had received one ploughing in the month of April; it now receives another ploughing, and is thoroughly worked by harrowing, rolling, and gathering o weeds; and if this be not sufficient, it receives further ploughings, with such harrowing, rolling, and gathering of weeds a are sufficient to prepare it for being formed into drills.

The preparation of the land for turnips will usually occupy the month of May, and may lead into the month of June, but every effort which the state of the weather allows should be used to get the land as far as possible prepared during the month of May.

In this month the operation of thrashing has become partial; and towards the middle of the month when the cattle are turned out to grass it may be said to have nearly ceased for the season. The barn-yard of the farmer, indeed, may be generally considered to be cleared in this month, except to the extent of such stacks as may be reserved for thrashing for litter in summer, and for affording straw for thatching the new stacks when harvest arrives.

The middle of this month is the usual period for farm-servants to enter to their new situations, or change from the old. It is then, too, that the farmer will most conveniently balance his yearly accounts.

The more active period of the household dairy begins with the month of May, and continues till the end of October, when the cows are put on their winter food.

During this month the land in oats should be weeded, bands of females or young persons passing along the ridges with the weed-hook.

In the month of May, then, the following have been the principal labours of the farm:—The sheep have been kept at grass during the month, and towards the middle of it the cows and steers have been turned out to their respective fields; the fat cattle have been disposed of; the cows have received the male, and so likewise have the mares; the calves receiving milk have been turned out to their little paddock: if any barley land has not been sown, or stones have not been gathered, it has now been done; the preparation of the turnip-land has been proceeded with, and the early-sown turnips have been sown; the potato-drills have been levelled; the corn has been weeded; the thrashing of corn has been carried on in so far as it has been necessary; and the operations of the household dairy have been attended to.

JUNE.

Live-stock.—The cows and steers are pastured in the field during the month. All the calves will be weaned during this month, and turned out to graze for the remainder of the season. Such of the cows, heifers, and mares as have not received the male now receive him.

At the beginning of the month the horses should receive green forage, and towards the middle of it they may be put at night in the pasture field.

At the beginning of the month the ewes with their lambs, and the ewe and wether hogs, are at grass in their respective enclosures; and at or before the beginning of the month they are washed, and in eight days afterwards shorn.

In ten days, or as soon as convenient after shearing, the wether hogs, now dinmonts, and such of the ewe hogs, now gimmers, as are not to be retained on the farm for breeding, may be sold.

The wool which has been shorn is to be put in a dry place and sold as soon as a market offers.

Labour.—The turnip-land, in so far as it has not been worked during the previous month, is to be now worked. As soon as it is ready to be formed into drills, the dung is to be spread and the seeds sown, the yellow turnips now being the first in order of being sown, and then the white.

The potatoes are to be horse and hand hoed.

The summer-fallow is to receive its cross-ploughing, and then to be well harrowed, all weeds being carefully gathered. After this, the further working of the summer-fallow proceeds as expeditiously as the nature of the weather and state of the labour upon the farm allow. The turnips are to be horse and hand-hoed for the first time. Lime is also being got forward to the land which is to be limed.

These, then, have been the principal operations of the month of June:—The cattle have been put to grass; the females not yet covered have received the male; the horses have been put on green forage; the sheep have been shorn, and the dinmonts, and the gimmers not reserved for breeding, have been sold; the wool has been disposed of as a market offered; the turnip-land has been worked, and the turnips have been sold, the potatoes and turnips have been horse and hand hoed; the summer-fallow has been worked, and lime got forward.

JULY.

Live-stock.—The whole of the cows, oxen, and weaned calves, are at grass, and are kept so during the month.

The horses continue to receive green forage during the day, and may be permitted to pasture in the fields at night; and this method of feeding may be continued during the month. But their work having become easy towards the middle of the month, their allowance of corn may be lessened.

At the commencement of the month the ewes with their lambs are in their former fields of grass; by the middle of the month the lambs are weaned; and from this time forward the lambs, now termed hogs, are kept separate from the breeding ewes.

Labour.—In the early part of the month the hay, when ready, is mown; it is worked, put into cocks, and then into ricks in the field: or else it is carried at once from the cocks to the stack.

In the mean time, the fallow-land is worked as the state of the weather allows. It received its first ploughing lengthwise, in April; it received its next ploughing across, immediately on the preparation of the turnip-land being finished, when it was well harrowed and worked; it is again ploughed, and further harrowed and cleaned: and it is ploughed again, worked and formed into ridges. When thus prepared, it is ready to receive the dung, which being spread is covered by a ploughing.

During this month, too, lime is brought forward to the fallow-land. It is laid in large heaps in the field to be slacked; it may be applied at the same time at which the dung is applied, or at a later period.

During the month, the turnips are again horse and hand hoed; and, by the end of the month, they may be set up by the double mould-board plough. The potatoes, too, during this month are horse and hand hoed, and by the end of the month they are set up.

These, then, have been the principal operations of the month of July:—The lambs have been weaned; the hay has been mown, worked, and placed in ricks; the fallow-land has been worked and dunged, and lime has been brought forward; and the turnips and potatoes have been horse and hand hoed.

AUGUST.

Live-stock.—The cows, steers, and calves, are at grass, and are kept so during the month.

The ewes are at grass in their own fields, and the ewe and wether hogs in theirs. The old ewes which are to be sold may now be selected from the rest of the flock, and marked for that purpose by the marking-iron; and, at the same time, all the other sheep may have their distinguishing mark put upon them.

The horses are receiving green forage, and, when the first crop of clover is consumed, they may receive tares until the second crop is ready. They may still be allowed to remain in the fields at night.

Labour.—In so far as the working of the fallow-land has not been performed during the last month, it is now to be done. Should the turnips not have been set up during the last month, they are now to be set up.

The hay, when ready, is to be brought home to the barn-yard and stacked.

The corn now becoming ripe, preparation is to be made for thatching the stacks, by forming the straw into bunches and making straw-ropes. Reapers having been engaged, the operations of the harvest are commenced and carried on in proportion as the corn is ripe. The corn that has been reaped, is, as soon as it is ready, carried home to the barn-yard and stacked.

These, then, have been the principal operations during the month of August. The cows, steers, and calves, have been kept on grass; the old ewes intended to be sold have been selected and marked, and all the sheep have been likewise marked; the labouring of the turnip-land and summer-fallow, in so far as it was not done in the preceding month, has been completed; the hay has been carried home to the barn-yard and stacked; the straw, in preparation for the thatching of the stacks, has been got ready, and the harvest operations have been begun and proceeded with.

SEPTEMBER.

Live-stock.—The cows, calves, and steers, are all at grass, and are kept so during the month. All the sheep are likewise at grass during the month; but before the end of it, the old ewes which had been marked for sale may be sold.

The horses are kept on green forage. As the month advances they are taken up from grass at night, and kept in the stable; and, at the end of the month, they are put again on hay and hard food.

Labour.—The reaping of the corn, in so far as it is not completed, proceeds with activity during this month, and it is carried home to the barn-yard as it becomes ready.

The lime, if not previously applied, is laid upon the summer-fallow land, which then receives the seed-furrow, and is sown.

These, then, have been the principal labours of the month of September:—The old ewes have been sold, and, towards the close of the month, the horses have been put on winter food; the operations of the harvest have been carried forward; lime has been applied to the fallow-land; and the wheat has been sown.

OCTOBER.

Live-stock.—At the beginning of the month the cows, calves, and steers are at grass, but as the month advances the cows may be taken up at night and receive green forage in the house.

Before the 10th of the month the rams are admitted to the ewes and gimmers.

At the commencement of the month, the ewe and wether hogs are still at grass, but towards the end of it, when the pastures fail, they are penned on turnips.

Towards the end of the month, too, as the pastures fail, the cows, calves, and steers are put finally into their winter-houses and yards; namely, the cows into their cow-house; the calves into a yard with sheds; the year-old steers, if not ready to be finally fattened, likewise into yards with sheds; and the two-year old steers into their stalls, or into small yards and sheds; the bull into a separate yard and shed; and the colts into their yard or paddock.

Labour.—If the wheat had not been sown during the last month, it is now to be sown.

After the stubbles are cleared of corn, the operation of ploughing the stubble-land commences, and is proceeded with till all the land intended for fallow and fallow-crops is ploughed.

The cattle being put into their respective yards, the process of thrashing for fodder and provender commences, and is continued throughout the winter.

These, then, have been the principal operations of the month of October:—The male has been admitted to the ewes and gimmers; the ewe and wether hogs have been put on turnips; the cows, calves, steers, and colts, have been put into their respective yards and stalls; the ploughing of the land to be in fallow and fallow-crops, has been carried on, and the thrashing of the corn has commenced.

The whole of this series of labours may be said to be comprehended in four periods, corresponding with the four quarters of the year,—winter, spring, summer, and autumn. The winter quarter comprehends the months of November, December, and January; the spring quarter, the months of February, March, and April; the summer quarter, May, June, and July; and the autumn quarter, August, September, and October; each of these periods being distinguished by labours peculiarly its own.

During the winter quarter, the cattle of different kinds are put into their yards, houses, and stalls, and fed on straw and turnips, or other succulent food, and the horses are put on their winter provender, consisting of straw, with a short allowance of corn. The breeding ewes having previously received the male, are kept on grass, and receive hay in hard frosts and snow, and the young sheep are penned on turnips.

The main employment of the horses, is ploughing the stubble-land for the next year's fallow and fallow-crops, and ploughing the grass-land, which is to be sown with oats in spring; they are further employed in taking corn to market, in bringing turnips to the stock in the yards and stalls, and, after the quarter is somewhat advanced, in carrying dung from the yards to the fields which are to be in fallow and fallow-crops.

Hedger and ditcher work, and draining and spade work of all kinds, proceed during this and the other quarters.

In the spring quarter, comprehending the months of February, March, and April, the cattle are kept in the yards with their allowance of straw and turnips, or other succulent food; the cows calve, if they have not done so in the last quarter. The ewes, when the period of lambing approaches, receive turnips; about the middle of the quarter they lamb, and are then put on new grass; and the young sheep are kept penned on turnips till April, when they are turned out to pasture for the season.

The labour of the farm now becomes active; the horses are put upon their full allowance of corn and hay; the oats are sown; the potatoes are planted; the barley and grass-seeds are sown; the land in wheat and barley, and the land in new grass, are rolled, and that intended for summer-fallow and fallow-crops receives its first spring ploughing. During this quarter, too, the thrashing of corn is carried on; and the dung is taken from the yards.

The summer quarter comprehends the months of May, June, and July. Soon after the commencement of the quarter, the fat cattle are sold; the cows and cattle in the yards are turned out to pasture; the cows and mares that have not received the male, receive him. As the quarter advances, the calves are weaned and turned out to graze; the sheep are washed and shorn; the young fat sheep are disposed of, and the wool is sold; and, before the conclusion of the quarter, the lambs are weaned.

The labour of this quarter commences with bringing forward any part of the spring operations not completed, and afterwards consists chiefly in working the turnip-land, in hoeing turnips and potatoes, and in preparing and manuring the summer fallow. The hay, too, is mown and ricked. Regular thrashing ceases soon after the commencement of the quarter. The horses are put on green food, and, after the labour of tilling the turnip-land is over, they are put upon a short allowance of corn. This, too, and the following quarter, are the active season of the household dairy.

The autumn quarter comprehends the months of August, September, and October. The cattle are kept on grass during this period, till towards the conclusion of it, when they are put in their houses and yards, and fed on straw, and turnips or other succulent substances; the horses, too, are put upon their winter food. The ewes are kept in their enclosures; and, about the middle of the quarter, the oldest and worst of them may be sold, their place being supplied by the younger ewes, which had been retained for that purpose; the breeding ewes receive the male; the lambs, now ewe and wether hogs, are kept in their enclosures, until the end of the quarter, when they are taken from grass and penned on turnips.

The labours of the quarter commence with bringing forward the work of the former quarter, and in securing the hay; the reaping and stacking of the corn proceed; the wheat is sown; the stubble-land is ploughed: And thus again begins the circle of the labours of the Farm.

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